



# ANNALS of SURGERY

A MONTHLY REVIEW OF  
SURGICAL SCIENCE AND  
PRACTICE

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# ANNALS *of* SURGERY

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## SURGERY OF DIABETIC GANGRENE\*

BY ELDRIDGE L ELIASON, M D.

OF PHILADELPHIA, PA

DIABETIC patients with gangrene are bad risks and need exceptional care and attention because of their advanced years, susceptibility to infection, delay in healing, and liability to acidosis. The present series of cases is no exception to that rule. In fact, this, perhaps, more than any other reported series, represents the worse risks possible, in that all of them were patients in a large city hospital, namely, the Philadelphia General Hospital, were of typical ward type, and most of them long unrecognized or untreated cases of diabetes before admission. The surgery was performed chiefly by four of the General Surgical Services.

An attempt is here made to give a statistical review of those cases of gangrene occurring in the diabetic patients in the Metabolic Wards of the above hospital, describing the treatment before, during and after operation. In 1926, the writer, together with Dr V W M Wright, reported fifty cases of amputation for diabetic gangrene, and at a later date, 1930, added 103 cases to this number. In the present article, further data are given on sixty-seven more cases of amputations. Consideration is given to the infections incident to the vascular disease, the precautions to be taken before and after operation, the type of anæsthesia employed, the specific surgical indications, the mortality, morbidity, and economic results as far as the patients' finally becoming useful citizens.

*Incidence of Gangrene*—In the last three years, of 1,305 diabetics admitted to the Philadelphia General Hospital, 175, or 13 per cent, developed gangrene requiring surgery, a high incidence when compared with Allans' figures for the year 1931 at The Mayo Clinic where of 684 diabetic patients only seventeen were operated upon for gangrene. Records are available at the University of Pennsylvania Hospital on 355 diabetics before the year 1923 and before insulin therapy. The per cent of gangrene in this number was 2.5. In 845 diabetics treated in the same hospital since 1923, the occurrence of gangrene was present in 6.2 per cent. The sex distribution in the above 175 cases was about the same. The ratio of occurrence in the white and Negro patients in this series was as 4 to 1. Fifty per cent of the patients did not know they had diabetes until admitted to the hospital with gangrene, 96 per cent of the gangrene occurred in the lower extremities. The average age of these patients was sixty-five years. General statistics throughout the country reveal that 20 to 25 per cent of diabetic patients die of gangrene.

\* Annual Oration before the Philadelphia Academy of Surgery, January 2, 1933

Our own follow-up figures show that 58 per cent of diabetic patients suffering with gangrene are dead within one year. These figures show the reason for the interest in diabetic gangrene, the seriousness of the condition, and why meticulous attention must be given all patients suffering with the condition and all diabetic patients who are apt to develop it. The age of the diabetic patient with gangrene determines to a great extent the prognosis. Gangrene seldom occurs in a youthful diabetic except as an embolic affair. Gangrene is a condition resulting from an inadequate blood supply which is usually the result of endarteritis obliterans.

Every untreated diabetic patient develops arteriosclerosis by the fourth decade. Arterial disease has been shown in diabetics under twenty years of age. Elsewhere it has been shown<sup>1</sup> that the diabetic form of gangrene occurs ten years earlier in life than does the senile form. Autopsies and operations on patients suffering with diabetic gangrene of the lower extremities show that the sclerosis is general, affecting particularly the coronary arteries, which condition is responsible for many of the deaths. Table I shows the comparative age of occurrence of gangrene in the present series and that of six

TABLE I  
*Occurrence*

Status	Year	30-40 %	40-50 %	50-60 %	60-70 %	70-80 %	80-90 %
Occurrence	1926	1 8	5 5	52 7	29 1	11	
Occurrence	1929-1932	1 2	8 6	22 0	46 0	18 4	1 8

Note the shift to the right after sixty years of age

years ago. The vascular condition is the underlying and determining factor in the cause of diabetic gangrene. Joslin, in 1923, found the average age for the development of diabetic gangrene to be sixty-one years. In 1926, we found it to be 59.2 years in ward cases. McKittrick and Root, in 1928, found the average age to be 64.1 years. In 1931, we find that gangrene has been delayed to the average age of 69.9 years. This represented a postponement of gangrene for more than ten years, a distinct advance in the welfare of the diabetic patient. Unfortunately, the figures dropped back to 61.6 in 1932, making an average of about 7 years. While improved results in the treatment of diabetics have of late been justly attributed to insulin therapy, modern surgical principles especially applicable to the diabetic have improved the mortality and morbidity results, as far as diabetic fatalities are concerned. There has been little change in the surgical results. (Table II)

TABLE II  
*Age and Incidence of Gangrene*

Author	Year	Average Age
Joslin	1923	61.0 years
Elhason and Wright (50 cases)	1926	59.2 years
McKittrick and Root	1928	64.9 years
Elhason and Wright (103 cases)	1931 (1st series)	69.9 years
Elhason (67 cases)	1932 (2nd series)	61.6 years

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The age of the patient should ever be borne in mind in the surgical treatment of these patients. The fact that insulin and other factors have advanced the age of occurrence of gangrene seven years indicates immediately that we are dealing with a worse risk than formerly and therefore must be more radical than ever in its treatment. Temporizing methods are dangerous where tissue resistance, the vascular system, the heart, lungs and the metabolism are in such a state that they easily develop myocardial failure, hypostatic congestion, pneumonia, uræmia and septicæmia, when procrastinating and insufficient surgical measures are adopted. The older the patient and the worse the risk, the more radical must be the surgery if life is to be saved and healing of the wound is to be obtained. Operations should be performed early, quickly, and at a sufficient high level to obtain good blood supply.

*Susceptibility to Infection*—Diabetic patients are particularly prone to develop infections, and, what is more to the point, they never bear it well. This is especially true when the infection is closed and undrained. Infection in a diabetic spells hyperglycæmia, acidosis, a poor response to insulin and metabolic therapy, and coma which often results in death. Procrastination in seeking surgical advice or delay in operating in such cases increases the mortality. A diabetic patient with moist gangrene, cellulitis, gas-bacillus or other infectious process, immediately becomes a serious case. Previously easily manageable, he now becomes much more difficult to diet regulation and insulin therapy. In such cases operation is necessary. Once early drainage, excision or amputation of the offending infectious process is accomplished, the temperature, pulse and respiration, acidosis and insulin therapy drop to normal standards.

Because the diabetic is more prone to infection, bears it poorly and responds immediately to the elimination of it, his advisor should be on the watch for early infection and immediately seek the advice of a surgeon acquainted with and interested in diabetic surgery. Such team work results in the best possible management of surgical diabetes. Under these circumstances it can readily be seen that prevention of infection before surgery is necessary and will lower the mortality and morbidity. With this in view, the Metabolic Division has only especially trained nurses in the wards whose business it is to see that their patients have the best of hygienic care, especially of back and feet, when gangrene threatens. Sterile precautions are applied to that particular part. In addition, a chiropodist is on duty to care for corns, calluses, etc.

*Conditions Demanding Operation*—From the standpoint of gangrene alone, the conditions demanding operation are, in priority of importance, gas gangrene, gangrene with cellulitis, moist or open gangrene, and dry gangrene. An analysis of our recent cases of gangrene shows that 87 per cent entered the hospital with moist gangrene or developed it while there. This justifies consideration. Moist gangrene is potentially infected and is soon



followed by local pus and rapidly spreading cellulitis and lymphangitis Dry gangrene should be kept so

Gangrene which is demarcated and without visible or clinical signs of infection may be treated conservatively (electric-light cradle or dry dressings) Moist gangrene, however, deserves careful attention as far as antisepsis, and supportive measures (dry heat, dry dressings, or electric cradle) prior to amputation Since moist gangrene is often followed by cellulitis, it behooves the observer to be on the watch for lymphangitis and cellulitis and to immediately seek early and adequate drainage or high amputation above the line of infection Procrastination and conservatism are the pitfalls of internists and operators

Occasionally, gas-bacillus infection enters the picture Here no delay can be tolerated by the patient Immunizing treatment and immediate excision or incision must be resorted to within a period of minutes or hours Speed in the treatment of this dread infection cannot be overemphasized Disproportionate pulse hurry with either a slight recognizable foul odor or slight subcutaneous crepitations, and with or without the usual late signs of typical discoloration and frothy discharge indicate immediate opening of the wound, or incision, excision and complete drainage of the suspected area The condition has a high mortality despite the best efforts in treatment

*Preparation of Patient for Operation*—In comparison with past surgical treatment of the surgical diabetic patient, the patient now arrives in the operating room as nearly balanced metabolically as it is possible to make him Carbohydrate, fluid and insulin requirements have been adjusted as far as possible to lend the patient the reserve, physiologically, that a normal patient has to possess for an operation Operation is deferred until the metabolic needs are taken care of or improved A few hours are usually sufficient in which to prepare the patient

As this part of the care of the patient is entirely in the hands of the metabolist Dr Edw S Dillon, chief of the department, has kindly outlined the following

*Pre- and Post-operative Care of Diabetic Surgery*—The principle upon which all pre- and post-operative care in diabetes is founded is to see that the patient receives three carbohydrate meals equal to the prescribed amount of carbohydrate in a twenty-four-hour diet If this is done, and enough insulin administered to keep the blood sugar normal, the patient will not develop ketosis

Of necessity, during so crucial a time in the diabetic's life, the diet must be light and easily taken In many cases a concentrated liquid diet will suffice, but in more extreme cases the diet must be administered by tube, hypodermoclysis, or even intravenously

*The Choice of Anæsthesia*—It is a well-known fact that certain anæsthetics tend to produce acidosis This is a factor in the order of choice of

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anæsthetics to be used and the anæsthetics in order of their desirability are as follows

(1) Local Anæsthesia Produces no changes in metabolism and is to be preferred in all cases where minor operations are performed and other cases that would not stand a general anæsthetic

(2) Spinal Anæsthesia Also causes no disturbance in metabolism and is the anæsthetic of choice born of necessity in operations on the lower extremities, perineum and lower abdomen, providing there is no contra-indication due to the patient's general condition

(3) Nitrous Oxide Oxygen Does not tend to produce severe metabolic disturbance unless unduly prolonged Not a good anæsthetic, however, when relaxation is desired

(4) Nitrous Oxide supplemented with Ether Produces better relaxation, more apt to cause acidosis, due to the ether

(5) Ether If prolonged it is certain to be followed by acidosis, as indicated by fall in the carbon-dioxide combining power It can be used, however, if this fact is borne in mind and the necessary post-operative measures taken to combat acidosis

(6) Chloroform Produces an extreme acidosis and is mentioned only to be condemned It should never be used on a diabetic

As a routine on all surgical diabetics a blood-sugar and carbon-dioxide combining power should be performed on all patients prior to operation If the  $\text{CO}_2$  shows any appreciable drop below normal operation should be deferred until the acidosis has been treated This is an inviolate rule, even if the operation is designed to remove the cause acting to produce acidosis A patient will survive the operation, but very often will not survive the acidosis following the operation On the other hand, if the acidosis is treated first, he will survive them both A routine blood sugar and  $\text{CO}_2$  should be performed within five hours after operation, especially if anæsthetics in groups of 3, 4, and 5 are used

*Insulin*—Granted that the patient has been well standardized before operation, we continue his required dose, increasing it as required when the blood sugar tends to rise For this reason it is necessary to have daily blood sugars or even sugars at twelve-hour intervals in the more severe diabetics

*Indication for Operation*—In general, it may be stated that the indications for operation are identical with the non-diabetic The presence of diabetes is not a contra-indication for any operation, providing the pre- and post-operative care can be supervised by one familiar with metabolic treatment In fact, there are some cases in which the presence of diabetes more strongly indicates prompt operation Any collection of pus, as the result of infection in a diabetic, demands prompt incision and free drainage, and this is a motto in diabetic surgery A diabetic's life may be lost in deferring a leg amputation twenty-four hours The absorption of the products of an infection is attended with decreased carbohydrate tol-

erance and a resulting tendency toward acidosis Experimentally, pus can be mixed with insulin and injected into a laboratory animal with no hypoglycæmic response, showing the neutralizing effect of pus upon the insulin in the diabetic's body

In operations upon extremities, incision and drainage of abscesses, the patient receives an enema the night before In amputations of the lower extremities, spinal anæsthesia is generally used, whereas in the other operations, local or short nitrous oxide oxygen anæsthesia is required All cases of amputation receive a prophylactic dose of 25 cubic centimetres perfringens antitoxin before operation The morning of operation the patient receives orange juice, enriched with glucose, with the usual dose of insulin This is given in the morning at 6 A M, in order to allow its passage through the stomach, and thus diminish the danger of vomiting when nitrous oxide and oxygen are used The patient, of course, receives pre-operative morphine and atropine If not nauseated and vomiting following operation, patient is allowed orange juice Very often it is advisable to pass a gastroduodenal tube immediately upon the patient's return to the ward, and administer orange juice, glucose and fluids by this route Of course, if the patient is nauseated and vomiting, the carbohydrate must be administered in saline, either hypodermically or intravenously Nausea and vomiting should be treated by passing a tube and lavaging the stomach with warm 2 per cent sodium bicarb

*Fluids*—Fluid intake before and after operation is even more important in diabetic patients than in others In the latter, one can be content with a daily intake after operation of 2,400 cubic centimetres, but in the diabetic, 3,000 cubic centimetres, or more, are needed during the twenty-four hours preceding and following operation This avoids dehydration To accomplish this, a charted amount is administered by mouth, Jutte tube, under the skin or intravenously, and a daily intake and output chart kept as long as needed Saline or tap water may be supplied by bowel also, but glucose by bowel has been discarded by the author as unreliable in supplying a desired caloric requirement Blood-sugar determinations before, during and after the administration of glucose by bowel in a series of diabetic cases attest the conclusion that it cannot be relied upon to supply caloric needs

*Specific Treatment*—The local and general care of gangrene depends upon its type and extent as well as upon the general condition of the patient Dry gangrene, moist gangrene, gangrene complicated by cellulitis or frank pus and gangrene with gas-bacillus infection require different treatment Temporizing or conservative measures may be adopted with the first, but not with the latter The author is generally in favor of high (mid-thigh) amputations, but does occasionally perform the Stokes-Gritti and other lower amputations by request or where special circumstances indicate that a low amputation is justifiable

*Dry Gangrene*—Dry gangrene is never considered a condition requiring immediate operation Because of this, conservative treatment is given

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This consists of an electric-light cradle over the foot of the bed to keep the area dry, maintain warmth, promote good circulation and avoid pressure over the affected part. Simple dry dressings may be used if desired or proved to be more practical. Conservative treatment in these cases permits sufficient time to standardize the patient's metabolic requirements and for the formation of a line of demarcation in these few cases where a low or leg amputation is to be considered.

*Moist Gangrene*—Eighty-seven per cent of the 170 cases were of the moist gangrene type. This figure is entirely too high with our present early detection of diabetes. Advice should be given all diabetic patients, and physicians as well, to avoid moist dressings and ointments at the first sign of an infection or early gangrene. Heat and moisture together are not borne well by diabetic tissues and often an infection or threatened gangrene is made worse by maceration through the popular treatment of hot salt-water dressings or the sealing in of infection by an unguent.

In comparison with the dry form of gangrene the moist type is usually attended by lymphangitis or some cellulitis. Because a diabetic cannot handle infection well it is customary to operate upon these cases as emergencies. Invariably they are operated upon at least within twenty-four hours. Simple dry dressings or the electric-light cradle is used temporarily to treat the condition locally and the extremity is elevated. The patient is fairly standardized by morning as a result of the metabolic treatment previously outlined. All cases of this type should be drained as the stump above the level of gangrene is traversed by lymphatic vessels and veins which have been carrying infection upward. A split tube in the depths of the wound before closing will usually insure adequate drainage. The drain is removed within twenty-four to forty-eight hours. If infection makes its appearance, the wound is opened freely.

*Infected Gangrene*—Gangrene complicated by cellulitis or frank pus is a serious condition and should be treated as an emergency. This condition is often the result of neglected moist gangrene and is another indication for early operation in such cases. A diabetic patient with infected gangrene usually presents a high temperature, pulse, respiration, acidosis or impending acidosis, delirium and toxicity. They respond poorly to insulin and metabolic measures. These are the cases that respond so rapidly to incisions, judiciously timed and placed, or high amputation with drainage or the stump left open. It is unwise to wait, here, for standardization of the patient's metabolic condition. One can only delay a few hours to prepare the patient as well as possible for an immediate operation. We only delay if laboratory examinations show the presence of severe acidosis. Then alkalis are administered, glucose and insulin are given in extra amounts until the patient's  $\text{CO}_2$  is within or near normal limits. First, a blood-sugar and  $\text{CO}_2$  determination are made. This indicates the amount of glucose and insulin that should be given to temporarily tide the patient through the operation and prevent further acidosis. Glucose is given intravenously, insulin

hypodermically and a Jutte tube is passed and left in place for immediate post-operative introduction of lactose and fluids. As these patients are often delirious or semicomatose, fluid and carbohydrate intake are assured by administration of the same through the tube. When the cellulitis has extended high up the limb, a guillotine amputation left open is indicative.

*Gas-bacillus Infection in Gangrene*—Within the last two years we have encountered fourteen cases of gas-bacillus infection in patients with diabetic gangrene. Owing to the susceptibility of diabetic patients to infection, the presence of gas gangrene is even more dreaded than in other patients. Ten of our cases were post-operative complications. Immediate wide excision and drainage or higher amputation must be performed. Where a stump has become infected, it is best to immediately cut all sutures, lay the wound wide open, debride all questionable tissue and irrigate frequently with peroxide or Dakin's solution. Even with the best of treatment the mortality in gas-bacillus infection in diabetics is extremely high. Perfringens antitoxin should be given intravenously and intramuscularly in twenty-five to fifty cubic centimetres doses and repeated as indicated depending upon the individual case. Repeated excision of chocolate-colored and frothy muscle or high amputations may be necessary. The treatment of gas-bacillus infections in diabetics has been extremely disappointing in our hands. The fact that 78 per cent of our cases with gas infection have died indicates why we feel the way we do. Our present feeling is that, if properly immunized previously, a diabetic stands a fair chance toward recovery. If, on the other hand, he has not been immunized against it, his poor circulatory and physiological condition precludes the results often observed in non-diabetic patients in whom the mortality is not nearly so appalling. During one period when perfringens serum was available, thirty-three of forty-three cases obtained it before amputation, in this number four developed the infection, of which two died.

*Operative Consideration*—In considering what operation to perform upon a patient with diabetic gangrene, less consideration should be given as to where and how much gangrene is present, than to how old is the patient, with regard to the vascular disease how old is the gangrene, and how much infection is present. The immediate condition and result should not necessarily take precedence over the future result. Rather should the latter be considered first and then the proper procedure be determined upon. A patient with dry gangrene, in the forty to fifty decade, can often suffer an amputation of a toe and have no further trouble for a number of years. Another, of the same age, with cellulitis and lymphangitis, or still another who is sixty years of age, but with dry gangrene of the foot or ankle will do better, in the long run, with the high amputation. Local and general conditions must be weighed in every case and each should be treated individually, but under broad general and basic principles. Experience shows that, as a general measure, high amputations are preferable. Various statistics and immediate results are often misleading. Careful consideration of post-operative and end-

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results frequently shows that preconceived and hoped-for results are not borne out. For example, in amputations performed below the knee the hospital mortality (thirty days) was 56 per cent, in amputations of the mid-thigh area, the mortality was practically the same, 55·8 per cent. These figures constitute only immediate results and banish the fear that the thigh amputation gives a greater surgical mortality rate. End-results showed, moreover, that none of the high amputations required further surgery, but that in those with operations performed below the knee, multiple surgical intervention was necessary with an increase of 15 to 20 per cent unfavorable results. It is of interest to note in Table V that in the series of twenty-five deaths, eleven of the cases were noted to have had extension of the gangrenous condition as a causative factor in their death. This, of course, is indicative of poor blood supply at the operative site. If above the knee, it indicated a hopeless situation, if below the knee, it probably meant too low an operative level. In a previous article we have shown that re-amputations or multiple surgical procedures are attended by an increased hospital mortality of 15 per cent in comparison with primary high amputation. In our recent cases with improved care, the futility of conservative and procrastinating surgery is clearly shown. In selected cases conservative operation is justifiable. As a workable thesis we believe that the lower the amputation the higher the mortality and conversely, the higher the amputation the lower the mortality. In fifteen cases where procrastinating surgery had been performed, there was a mortality of 66·6 per cent (in comparison with 55·8 per cent) and 86·5 per cent unfavorable results, resulting in thigh amputation finally.

*Anæsthesia*—Selective spinal anæsthesia is used routinely in gangrene of the lower extremities. Eighty per cent of the cases were operated upon under spinal anæsthesia, 17 per cent under local and only 3 per cent had gas or ether. Spinocaine and novocaine were the agents generally used. By selective spinal anæsthesia is meant the selecting of the level of operation and the placing of the level of anæsthesia to a point just above the operative site instead of the routine administration of trunk anæsthesia. With rare exceptions all thigh amputations had spinal anæsthesia.

When operations are performed with a low blood-pressure, many bleeding vessels are not visualized at the time and consequently are not ligated. This low pressure can be prevented by ephedrin given twenty to thirty minutes before the anæsthesia is administered. When the fallen blood-pressure returns to normal later on, hæmorrhage occurs, and the wound has to be opened or it will often become infected. Local anæsthesia has a tendency to traumatize and so further devitalizes the already weakened tissue, gas anæsthesia is not a safe anæsthetic in old patients with high blood-pressure and arteriosclerosis.

*Operative Technic*—After pre-operative consideration, operations should be performed quickly, neatly and thoroughly. Teamwork is essential. A mid-thigh amputation can be performed in a very few minutes. Under low

spinal or a short gas anæsthesia, there is hardly any reason why almost any properly prepared diabetic patient cannot be relieved of a menacing gangrenous limb

Without a tourniquet the limb should be removed by the transfixion method. Care should be used in not making long and thin antero-posterior flaps. It is best to make the flaps as short as the condition of closure will permit. The transfixion method is much quicker and less traumatizing than the dissecting and prosthetic method. The Gritti-Stokes operation is sometimes used. Rigid hæmostasis is required to prevent hæmatomas that lead to infection. Hot saline irrigations prior to closing both remove all blood-clots and stimulate muscle ends made cold by air exposure. No attempt is made to suture individual muscles to each other, thus avoiding constricting muscle sutures that result in necrosis. Muscle bundles are, however, approximated by fascial sutures and wound compression. Interrupted mattress sutures of iodine catgut insure contact and allow for wound tension. Drainage is inserted and the skin edges are approximated by interrupted silk sutures. The latter have the advantage that if a localized hæmatoma or infection occurs, the wound can be opened at that point by clipping a single suture without detriment to the rest of the wound. A large dressing of loose gauze is then applied to the stump and the operation is completed.

*Drainage and Post-operative Dressings*—Infection, latent or present, is often not suspected. Especially is this true in diabetic patients. Since a drain causes no harm and is an excellent insurance if infection be present, it seems desirable. In some cases a drain has been placed in the depths of the wound reaching down to the bone end. This is withdrawn in twenty-four hours if no infection appears. Laterally, however, we have introduced a drain designed to meet physio-anatomical requirements with happy results. This consists of a drain inserted through a stab puncture, before the wound is closed, in such a manner that the tube drains postero-laterally at a point opposite the bone end. As the most comfortable stump position is slight flexion, this method of draining permits postural drainage, comfort and freedom from excretory soiling. Table III shows the incidence of wound infection and the reason why drainage is desirable. In badly infected cases, with cellulitis and lymphangitis, the guillotine operation is employed and no suture used.

TABLE III  
*Wound Complications*

Closed Wounds	Cases	Per Cent
Clean	49	44 1
Type A (Serum)	13	11 7
Type B (Stitch abscess)	2	1 8
Type C (Break down)	47	42 3 +
Totals	111	99 9

NOTE—Type C is the only serious complication jeopardizing wound, increasing hospital stay or endangering life

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*Type of Operation*—Seventy-six per cent of the amputations were in the thigh, 10 per cent were primarily leg amputations which required a higher operation later, only the lower operation being permitted by the patient or family at first. Minor operations comprised 14 per cent of the cases which were either too ill or permission was not obtainable for a higher removal. Five of the 175 refused treatment.

*Delayed Healing*—Clean wounds in diabetics do not heal as kindly as in non-diabetics. Because of the increased susceptibility and the decreased resistance of the diabetic patient, wound complications in the diabetic occupy a higher ratio than in others. This is a result of local tissue changes which may be divided under the head of altered vascular and metabolic function. Forty-two per cent of the amputation wounds showed some form of infection resulting in a severe diffuse suppuration. This is a vastly higher incidence of wound infection than occurs in general surgery where it runs from 4 to 6 per cent. Since wound infection has such a high incidence, it behooves us to drain all cases to obtain a dry wound free of blood and serum. From time to time cases are cited that heal perfectly when closed "tight." All too often this does not occur. A small drain to the cut end of the bone does much good and no harm in its twenty-four-hour stay. Experience and statistics bear this out in the present series, but it is only fair to state that other writers close all such wounds with reported good results. These figures are very bad and could be charged possibly to poor technic, but the reader will recall that 87 per cent of these cases were primarily infected, and hence probably had cellulitis or at least lymphangitis at the site of operation before the incision was made. Studies instituted since this was written have shown in some instances that cultures taken at the time and site of operation have revealed organisms present there similar to the organisms found in the lesion lower down.

Of the serious wound infections (pus) forty were cultured. Table IV shows the prevailing organisms. The high incidence of gas-bacillus infection is attributable to a certain brand of catgut on the market as was proved by laboratory cultures and controls of used and unused material. An occasional case of gas-bacillus infection may be encountered in amputation cases where the patient is incontinent, delirious, or where for other reasons the contents of the intestinal tract have soiled the amputated area before or after operation.

TABLE IV  
*Type of Wound Infections*

Organisms	Cases	Died	Mortality %
B. Welchii	14	11	78
Hæm. Strep.	13	8	60
Strep. Viridan	3	2	66
Staph. Aureus	5	1	20
B. Proteus	3	0	0
B. Diphtheriae	1	0	0
B. Coli	1	0	0



The hæmolytic streptococcus and the *streptococcus viridans* seem to be the organisms most generally dangerous to the diabetic patient. Leaving the incidental gas-bacillus infections out, these two organisms represent 47 per cent of all infections and are concerned in 95 per cent of the mortality in the infected cases.

*Operative Complications and Results*—Previous to 1927, 37.5 per cent of the diabetic gangrene patients died of diabetes. This was due partly to the prevailing treatment. Surgical diabetics were admitted directly to the surgical wards and received varying types of surgical and medical treatment. The surgical condition usually received early operative intervention, which was often performed under ether anæsthesia, and starvation before and after operation, which practice only tended to increase acidosis and mortality. The metabolic requirements of the patient were injudiciously handled by a surgeon or an occasional visiting medical consultant. In other words, the surgical condition was treated first and the metabolic condition secondarily, and often inadequately. Neither is sufficient without the other.

The present series of cases represents an entirely different method of treatment. This group was admitted to the metabolic ward, treated there for their diabetes and operated upon after surgical consultation. In the past the surgeon has erred as far as adequate metabolic treatment is concerned. Now that diabetics reach the medical man first, he must not err, as has the surgeon previously, to seek early consultative advice. Whereas teamwork always works for the best, here it is imperative. Procrastination or independence on the part of either the surgeon or metabolist works for only one end-result—increased mortality.

Operations under the older form of surgical treatment (routine starvation before and after operation, ether anæsthesia, low fluid and carbohydrate intake afterward) have been superseded by the elimination of starvation, dehydration and acidosis through proper preliminary standardization, caloric and fluid requirements, spinal or gas anæsthesia and proper metabolic treatment immediately after operation. The latter method makes for a lower incidence of acidosis and of complications, and for better operative results.

*Results*—In comparison with results of five years ago, today's results are both disappointing and pleasing. Immediate operative results are no better, but end-results seem to be a little better. Improved metabolic treatment, better preparation of the patient for operation, and improved anæsthesia technic have worked for a much lower mortality due to diabetes *per se*. The reason for poor end-results is accredited to the patient's age. In 1926, the average age of individuals developing gangrene under the then existing form of treatment was 59.2 years. Now that improved metabolic treatment has advanced the age of occurrence of gangrene to 65.6 years, we have a more diseased patient to cope with. Not only is his diabetes in a more advanced stage, but his kidneys, heart, lungs and tissues are much weaker than a decade previously. Added to this (which is the most important) his arterial tree is far more sclerosed than before. As gangrene depends upon inade-

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quate circulation and its prognosis upon the arterial tree above, it is obvious that we are dealing with a worse risk than previously

An analysis of the last five years shows that 42 per cent of diabetic patients with gangrene died in the hospital and that 55 per cent were dead within a year. The higher per cent figures are those including ten cases of gas-bacillus infection. Surely this is not very cheering. Despite these gloomy figures, though, the diabetic patient with gangrene is better off today than five years ago as he lives about seven years longer before gangrene appears.\*

*Causes of Death*—As stated above, the commonest cause of death in these cases is myocarditis with coronary thrombosis. Many other contributing factors are usually concerned in each case, so that three and four—sometimes five—diseases will appear on their post-mortem sheets. Table V lists the conditions and the frequency of their occurrence in twenty-five deaths as entered on the death certificate.

TABLE V  
*Causes of Death (25 Consecutive Cases)*

Disease	No. Cases
Diabetes	25
Myocarditis	17
Infection (including gas and streptococcus)	8
Gangrene (extension of original process)	11
Sclerosis (advanced)	6
Toxæmia	4
Senile dementia	4
Pneumonia	4
Miscellaneous (decubitus, senility, etc.)	8

It will be seen that in eleven of the twenty-five cases, extension of gangrene in the stump was noted. The anterior flap was the one chiefly involved, meaning that this flap had the poorer blood supply. This bears out the observation of the writer made at the time of operation, namely, that more ligatures are necessary in this flap. The literature confirms this in the finding of increase in the size of the arterial trunks in the sciatic tree. This increase is very marked in the supply of the sciatic nerve itself.

*Follow-up and Economic Considerations*—In 1926, our operative mortality (twenty-four hours) was 3.6 per cent and our hospital mortality (thirty days) 43.6 per cent. We had no follow-up at that time. With improved metabolic treatment, anæsthesia and operative technic, we naturally expected a vast improvement. Actual figures, however, show that in 1929-1932 the

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\* Figures obtained from the University of Pennsylvania records show that the average age at death of all diabetics before insulin in 1923 was thirty-seven years and since the advent of insulin, the average age at death has been fifty-one years, an addition of fourteen years to the diabetic's life. One can easily appreciate when comparing these figures, fourteen with the seven at the Philadelphia General Hospital, the difference in the character of the material at these two hospitals. In both hospitals the post-mortem reports show that circulatory disease has been by far the most pronounced cause of death.

operative mortality is 3.5 per cent and the hospital mortality (thirty days) is 41.8 per cent, but the follow-up mortality for one year is 55 per cent, as against 61.1 per cent years mortality two years ago. The one-year mortality figures include the operative as well as the hospital mortality (Table VI)

TABLE VI

*Mortality Figures*

Year	Operative (24 hours)	Hospital (30 days)	1 Year
2-1926 (50 cases)	3.6%	43.6%	61.1%
1929-1932 (170 cases)	3.5%	41.8%	55.0%

The very nature of our follow-up problem in this class of patients with frequent change of address, many of them foreigners, the wide area of the entire county of Philadelphia to be covered and oftentimes the difficulty of location and time consumed in long distance calls, hampers the collection of data. In the last eighteen-month period (January, 1931 to July, 1932) of sixty-seven cases operated upon, thirty-four cases left the hospital alive, and of these twenty-eight have been followed (Table VII)

TABLE VII

*Mortality Figures (Continued)*

No. Cases	Months after Operation	% Living
28	1-6	100.0
20	6-12	71.0
8	12-18	28.5
3	18-24	10.4

It is seen from this limited number that only 10.4 per cent are alive after eighteen months.

Joslin has remarked that a gangrenous diabetic toe costs some one (patient or taxpayers) \$500. Conservative treatment and multiple operations with increased mortality and funerals are apt to double this figure to \$1,000 without any attending gain of any kind. Logic, it would seem to us, should point out that we must give the subject of diabetic gangrene a careful thought when treating this condition. At the risk of being regarded as radical, the writer wishes to reiterate that in his opinion the best form of treatment in ordinary diabetic gangrene (favorable selected cases excepted) both as regards the immediate and end-result, is an early, high, quick, and drained amputation. Past experience has proven this. In those cases surviving operation the average hospital stay was 62.2 days. The average hospital stay of the entire group of 170 cases was 36.5 days.

The writer is in favor of high amputation. Seventy-six per cent of the cases were mid-thigh amputations. The reasons for this attitude are (1) multiple operations make for increased mortality, (2) it is generally hopeless to amputate a foot or a leg when the arteries immediately above it are hopelessly diseased and incapable of supplying good circula-

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tion, (3) from an economic and functional point of view a thigh stump is preferable. In addition the majority of these patients, because of their advanced years, diabetes and attending complications, rarely do anything in the way of a useful occupation afterwards. Saving them a few inches of extremity, which they will probably never use, at the expense of further operations and increased hospitalization and mortality, seems to be an unwise procedure.

Insulin therapy has been accredited largely with the improved results obtained in the treatment of diabetes and diabetic gangrene. This is possibly only one of several factors which should receive credit. Earlier recognition of diabetes and consequent earlier treatment have improved the status of the diabetic patient immeasurably. This has been brought about by widespread publicity through the radio, newspapers, magazines, health programs, industrial and insurance examinations, and an awakening interest in the public at large in yearly examinations. Because of this the surgeon will see more cases of diabetes in the future demanding his advice. Physicians likewise have been aroused to the benefits of proper dietary régimes and insulin therapy.

All diabetic patients should be warned against infections, cutting corns, calluses, *etc.* Physicians should now be warned against three different things concerning diabetic patients. First, never apply hot wet dressings to gangrenous or infected toes—the poor or absent circulation often results in blisters, infection and moist gangrene, second, never apply ointments to an infected wound in a diabetic—ointments are not necessarily sterile, in fact are most often the reverse—dry dressings and mild dry heat are best in either of the above conditions, third, never fail to call in a surgeon for consultation when infection or possible gangrene threatens.

Many surgeons in the past have erred in the proper medical treatment of surgical diabetics in inadequately caring for their metabolic needs. Now that these patients come to the medical man first and the surgeon only sees the patient when an operation is decided upon, better results should be obtained. Occasionally, the surgeon is called after semisurgical care has been carried out for days or weeks and finds a hopelessly infected case with acidosis. The surgeon and the internist should work hand in hand. Happily, this is the method of treatment at the Philadelphia General Hospital. All patients are admitted to the Metabolic Division and a request for a surgical consultation is immediately answered whenever a condition suggesting surgery appears. The patient is treated pre- and post-operatively in this department where especially trained assistants, a private laboratory and a special diet kitchen are ever waiting to supply his metabolic requirements.

*Summary*—A group of 170 diabetic cases operated upon for gangrene has been analyzed. Gangrene affected 13 per cent of the diabetics in the Philadelphia General Hospital.

Over 95 per cent of gangrene was in the lower extremity

Fifty per cent of the 170 gangrene cases did not know of their diabetes until gangrene occurred

Open gangrene with infection is the commonest and gives the poorest results, 87 per cent of this series

Infection played a part in 95 per cent of the fatal cases, *B welchii* and *streptococci* being the chief offenders

Early surgery in properly prepared diabetics is essential Pre-operative insulin, carbohydrates, fluids and perfringens antitoxin are necessary

High amputations (mid-thigh)—76 per cent were mid-thigh and single—with drainage in infected cases, gave the best results Transfixion and guillotine methods were the rule without tourniquet Spinal anæsthesia was used in 80 per cent of the cases, local in 17 per cent

Diabetics with gangrene have had seven years added to their lives by modern method of treatment Operative mortality (twenty-four hours) was 3.5 per cent, hospital mortality 41.8 per cent, one year mortality, 55 per cent, in last sixty-seven cases a slight improvement over the previous series

Hospital days of the entire 170 was 365, of the survivals 622 days

Only 10.4 per cent of these last sixty-seven cases are alive after eighteen months

Education of the patient, the physician and the surgeon all working as a team is essential for the best results

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# EMBOLECTOMY FOR ARTERIAL EMBOLISM OF THE EXTREMITIES\*

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THE first successful embolectomy was done by Georges Labey,<sup>3</sup> in 1911. Since that time the procedure has had a steadily increasing use. Yet it has not received the recognition that its simplicity and brilliant possibilities warrant. In Sweden the majority of physicians are on the alert to utilize this operation. Elsewhere there exists a general tendency on the part of the medical profession to neglect the procedure. It would appear that many physicians are neither acquainted with the early signs and symptoms of embolism nor are aware of the possibilities to be derived from embolectomy. If this be true then there exists an obligation upon surgeons to acquaint their colleagues with the facts. That these may be readily available the literature has been reviewed and a statistical study made from all reported cases. To these data are added observations from personal experience.

As a direct result of close cooperation among the attending physicians nine early instances of peripheral embolism were seen during the past year. In two of these operation was not done because of serious embolism elsewhere. Seven embolectomies were done in six cases. The results of these were as follows. Two patients died within forty-eight hours from embolism in other regions (result indeterminate), two patients developed gangrene and required amputation, and in three instances the operation was successful.

CASE I—J S, SMH No 24,586. A woman of forty-two years had been treated two years previously by the medical staff for rheumatic heart disease with myocardial insufficiency, mitral stenosis, and auricular fibrillation.

On the day of admission, at 11 A.M., she experienced pain, coldness, numbness and paralysis of the left leg. The pain began just above the knee and soon involved the entire lower leg. Immediate admission to the hospital was obtained. When admitted the left leg was pale and cold below the lower third of the thigh. The foot had the appearance of post-mortem lividity. On the left side the femoral pulse was felt below Poupert's ligament but became imperceptible about one and a half inches below this structure. The left popliteal, posterior tibial and dorsalis pedis pulses were not palpable.

*Impression*—Embolism of the common femoral artery, left.

Operation was done under local anæsthesia five hours after onset of symptoms. No embolus was found in the common femoral artery. The superficial femoral was traced down to the middle of Hunter's canal where the obstruction was encountered. Arteriotomy was done and the embolus along with a small distal thrombus was gently milked out. The vessel was empty but did not bleed from its distal portion. A small, well-oiled scoop was passed down the lumen. In the lower popliteal artery another

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\* Presented before the Rochester Society of Clinical Surgery, November 11, 1932.

embolus was encountered, and removed. There was then brisk back bleeding. Arteriotomy was closed with interrupted silk sutures.

After operation the foot became warm and pink, but in twenty-four hours signs of a failing circulation developed below the knee. This was followed by gangrene which necessitated a mid-thigh amputation.

Dissection of the amputated leg showed a fragment of embolus in the popliteal artery from which an extensive thrombosis had occurred. This case serves to illustrate the uncertainty of indirect, instrumental removal of the embolus.

CASE II—B J, SMH No 47,028. A man of forty years had had two previous hospital admissions. The first was for rheumatic heart disease with mitral stenosis and auricular fibrillation and the second for gangrene of the right foot following embolism. This was treated by a mid-calf amputation.

Three months after his last admission, at 6 P M, he noticed numbness of the left foot. This was followed in fifteen minutes by pain in the foot and coldness of the foot and calf. He arrived at the hospital one hour after the onset of symptoms.

When admitted, the left foot and lower calf were cadaveric in appearance. It was cold to a definite level of demarcation in the midcalf. There was anaesthesia of the skin of the foot, but pain was elicited by deep pressure. The dorsalis pedis and posterior tibial arteries were pulseless. There was a slight pulsation of the popliteal vessel. It was reasoned that the embolus must be in the popliteal artery at the point of origin of the anterior tibial artery.

Operation, one hour and fifty-five minutes after onset of symptoms, was done under local anaesthesia. The popliteal artery was exposed at the point of bifurcation into its tibial branches, and was normal. The posterior tibial was traced down for approximately two inches. At this point arteriotomy was done and a catheter passed down the vessel. When an obstruction was touched, suction was applied and the catheter was withdrawn. This removed the obstruction so that vigorous back bleeding occurred. The arteriotomy was closed with interrupted mattress sutures.

After operation, though the foot was warm and of good color, the peripheral vessels did not pulsate. All of the obstruction had not been removed. There was gradual failure of the circulation of the foot, gangrene developed and a mid-calf amputation was necessary. Dissection of the vessels of the limb revealed two small emboli lodged in the anterior tibial artery, one eighteen centimetres above the malleolus and another at the beginning of the dorsalis pedis portion. The posterior tibial contained a fragment near its origin. The vascular tree had been obliterated by a propagating thrombosis from these foci of embolism.

The failure in this case is directly attributable to mistaken localization. Rather than one embolus blocking the popliteal artery at its bifurcation, there were small emboli in the peripheral vessels. The removal of multiple, small emboli is very difficult. Their localization is equally disconcerting. It is probable that in this instance visualization by arteriography would have been the only means of identifying the level of obstruction.

CASE III—R B, SMH No 57,383. A woman of forty-seven years was admitted to the hospital with rheumatic heart disease, auricular fibrillation and cerebral embolism. She was drowsy and stuporous but would respond to questioning. She gradually became more alert and responsive so that one week after admission she was considered improved. At noon of the eighth day, she relapsed into an unconscious condition. Examination at this time revealed evidence of cerebral and terminal aortic emboli. Both extremities were cold, cyanotic, and pulseless. The line of demarcation was on a level with the hip-joints. The patient was desperately ill, and would presumably die from the cerebral embolism. This was not certain, however, since she had nearly

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recovered from a similar accident. She was too ill to attempt a transperitoneal approach to the aorta, so it was decided to try the method of Key of retrograde removal through the femoral arteries.

Operation four hours after the embolism. Under local anaesthesia, both femoral arteries were exposed in Scarpa's triangle. The right was opened and an oiled catheter was passed up the vessel until the embolus was encountered. Suction was applied and the catheter withdrawn. Fragments of the embolus were obtained in this way but there was no bleeding from the femoral vessel. After several unsuccessful attempts to dislodge the embolus it was decided that it was too large to remove by this method. The wounds were closed. The patient died the following day. Autopsy showed a large embolus blocking the aorta from the renal branches to its bifurcation.

*Comment*—Key<sup>2</sup> devised the method of removal of an aortic embolus by the femoral approach. A small embolus, insecurely attached at the aortic bifurcation, might be dislodged by this method. In this instance the large size of the mass precluded removal. If the patient's condition permits transperitoneal exposure of the aortic bifurcation then the direct attack is to be preferred.

CASE IV—E. H., SMH No 57,341. A man of thirty-six years was admitted to the medical service with a diagnosis of hypertensive heart disease (blood-pressure 175/100) and coronary occlusion. This was confirmed by all clinical and laboratory examinations. There was no evidence of rheumatic myocarditis.

One month after admission, at a time when he was progressing satisfactorily, he experienced pain in the right hand. This was localized to the index and middle fingers. In thirty minutes there was pallor, decreased temperature and diminished sensation of these fingers. The radial pulse was perceptible. One hour after onset he had a pain involving the lower arm with some references to the shoulder. Two hours later, the pallor had involved the hand and forearm to within eight centimetres of the elbow-joint. This area was cold and numb. The radial and ulnar arteries were pulseless.

*Diagnosis*—Embolism of brachial artery at its bifurcation.

The patient was operated upon six hours after onset of symptoms under avertin-local anaesthesia. An embolus blocking the brachial artery at its bifurcation was removed.

The following morning the right hand and arm were in good condition, but at 8 A.M. he had severe pain in the left foot and calf of the left leg, which were pale, cold, painful and paralyzed with a line of demarcation about five inches below the knee. The left dorsalis pedis and posterior tibial pulsations were imperceptible while that of the popliteal and femoral were very weak. By means of an arteriogram<sup>5 26</sup> the peripheral



FIG. 1.—The accurate localization of the embolus in Case IV by arteriography. The arrow points to the level of the obstruction.



embolus was exactly localized in the posterior tibial artery just below the point of bifurcation of the popliteal (Fig 1) Two hours after the onset of symptoms, the embolus was exposed and removed The patient recovered with a satisfactory circulation in both the arm and the leg The X-ray made isolation of the embolus easy Without it an extensive dissection in search of the point of obstruction would have been necessary

CASE V—M C, SMH No 65,958 A woman, aged forty-seven, had had diabetes for five years with mild hypertension (blood-pressure 160/84) On the day of admission at 6 A M, she began to have pain, numbness, coldness and discoloration of her right hand and forearm These symptoms became progressively worse, and in the afternoon she was seen by her physician, who referred her to hospital for operation On

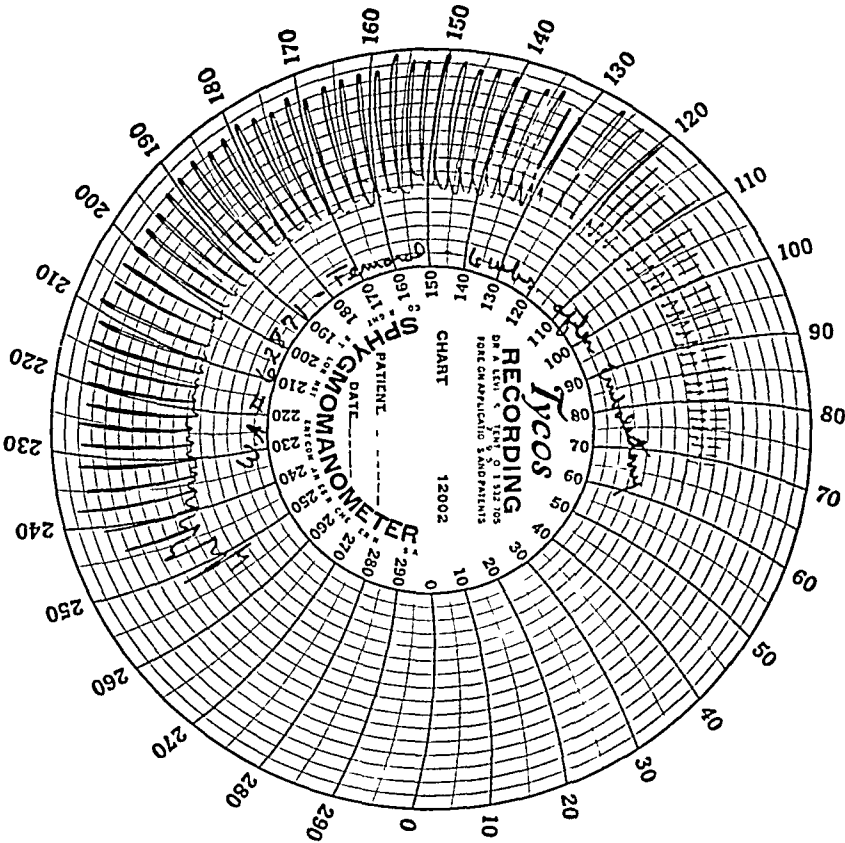


FIG 2—The normal pulse tracing distal to the site of embolectomy, six weeks after operation in Case VI

admission the right hand was cold, numb and blue The fingers were slightly flexed in a claw-like position The dark blue cyanosis of the fingers faded to a blotchy, red-dish cyanosis on the forearm This in turn stopped at a sharp level just below the elbow The radial and lower brachial pulses were imperceptible but high in the arm near the axilla a pulse was felt This was confirmed by the recording sphygmomanometer

The diagnosis rested between embolism and thrombosis of the brachial artery

Under local anaesthesia, operation was done thirteen hours after onset The brachial artery was found to be plugged from its origin to its bifurcation A wide exposure was obtained, an arteriotomy opening was made in the mid-portion of the brachial artery, and the material was gently milked out of the lumen of the vessel It was not markedly adherent to the vessel wall, nor was there evidence of atheromatous changes For these reasons the primary lesion was considered to be due to embolism After removal of the obstruction, brisk bleeding and back-bleeding occurred On closing the arteriotomy and removing the clamps a strong pulse was seen and felt in the brachial

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and its radial and ulnar branches. At the completion of the operation the radial pulse was perceptible but the hand was still somewhat cold and a little cyanotic.

The following morning the patient developed signs of cerebral embolism and died. Autopsy was refused so the source of the emboli was never determined.

CASE VI—W. A., SMH No. 62,871. A male, seventy years of age, was admitted to the hospital with acute urinary retention and a perirectal abscess. He was found to have generalized arteriosclerosis with hypertension (blood-pressure 170/100), arteriosclerotic myocarditis, pulmonary emphysema, arthritis, benign prostatic hypertrophy and an ischiorectal abscess.

A suprapubic prostatectomy was done. His convalescence was complicated by intermittent attacks of auricular fibrillation. By his twenty-sixth post-operative day his wound was healed and he was voiding per urethra. At 6 P. M. of this day he complained of tingling, numbness and paralysis of the left lower leg. When examined the foot was mottled by a dusky cyanosis with a very slow return of color after blanching the skin. The limb was cold to the mid-thigh. All vessels were pulseless except the femoral artery just below Poupart's ligament. *Diagnosis*—Embolism, common femoral artery.

Two and a half hours after the onset, under local anaesthesia, the femoral artery was exposed in Scarpa's triangle (Dr. W. J. M. Scott). The embolus was located at the profunda femoris branch. Arteriotomy was done in the common femoral. After extruding the clot brisk back-bleeding occurred from the distal portion. The wound was closed with a running stitch of silk, one interrupted suture being added to control a bleeding point. On removing the clamp proximal to the arterial incision the arterial pulsation was resumed in the superficial femoral, popliteal and pedal arteries. The foot became warm with a normal color. His recovery was uneventful. In Fig. 2 is illustrated the normal restoration of the peripheral pulse.

*Comment*—The age of this patient, combined with the presence of hypertension and generalized arteriosclerosis, makes the successful outcome more satisfactory. Arteriosclerosis does not constitute a contra-indication to embolectomy as is well illustrated by the case reported by Keller.<sup>23</sup>

*Literature Review*—The contributions of Carrel to the technic of vascular surgery made embolectomy possible. In turn the work of Key has made of the operation an established surgical procedure. In 1922, he was the first<sup>2</sup> to review the subject. Then reviews followed by Michaelson,<sup>4</sup> in 1923, Jefferson,<sup>1</sup> in 1925 and Petitpierre,<sup>6</sup> in 1928. In a paper published in 1929,<sup>2</sup> Key collected 226 cases of embolectomy reported up to the end of 1927. To this number I have added seventy cases (including the six here presented) representing seventy-nine embolectomies. This includes all cases published (and catalogued) up to July, 1932, and gives a total of 296 cases reported to date.

*Etiology of Embolism of the Peripheral Arteries*—An embolus afloat in the arterial stream has as its origin a thrombus in some part of the vascular system. Usually, the parent thrombus is located in the heart and is consequent to cardiac disease. Mitral stenosis with auricular fibrillation is the most common cause but other abnormalities such as coronary occlusion or vegetative endocarditis may give rise to the primary thrombosis. Conditions such as post-operative thrombosis, arteriosclerosis, infection or aneurysm may act as the source. Rarely a phlebitis may give rise to an arterial embolus by means of a patent foramen ovale (paradoxical embolism).

The following tabulation gives the various etiological sources in the group operated upon

Heart disease	198 cases—69.2 per cent	Aneurism	5 cases—1.8 per cent
Post-operative	37 cases—13 per cent	Abortion and delivery	5 cases—1.8 per cent
Infection and trauma	9 cases—2.1 per cent	Miscellaneous	8 cases—2.8 per cent
Arteriosclerosis	6 cases—2.1 per cent	Phlebitis	1 case—0.3 per cent

*Age and Sex*—In the group of 296 cases of embolectomy, 133 were males and 163 were females. The age of the members of the group varied considerably. The youngest patient was twelve years while the oldest was eighty-three. The tabulation according to age groups gives the following result

10-20 years—4 patients	51-60 years—74 patients
21-30 years—14 patients	61-70 years—63 patients
31-40 years—44 patients	71-80 years—21 patients
41-50 years—66 patients	81-90 years—3 patients

*The Location of Emboli*—Almost without exception embolism occurs at the bifurcation of a vessel or at the origin of one of its large branches. The components of the arterial system have a constantly decreasing calibre as their number increases. There is always a sharp narrowing of the lumen below any bifurcation. This being true, it is obvious how an embolus may float along freely in a main trunk but be unable to enter either branch of a bifurcation. Occasionally, it would appear that an embolus balanced astraddle of the bifurcation rather than being impeded by its disproportionate size. The major divisions of the system occur at the bifurcation of the brachial, aorta, common iliac, common femoral and popliteal arteries. The following tabulation shows these to be the points of greatest incidence of peripheral embolism

<i>Upper Extremity</i>		<i>Lower Extremity</i>	
Subclavian	2	Aorta	34
Axillary	18	Common Iliac	50
Brachial	40	External Iliac	10
Radial	2	Common Femoral	131
Ulnar	1	Superficial Femoral	11
		Popliteal	33
		Posterior Tibial	3

Some patients had multiple emboli. This accounts for the number of emboli being greater than the number of cases reported.

*Diagnosis*—The symptoms of peripheral embolism are very characteristic. They consist of excruciating pain, numbness, coldness and paralysis of the part involved. The pain is of sudden onset. It may start at the site of lodgement of the embolus but soon involves the entire extremity distal to this point. Occasionally pain is a late symptom coming on in forty-five minutes to two hours after the onset. Very rarely it may be mild or absent. The involved extremity is cold, numb and paralyzed. At first the severity of

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the pain may overshadow these sensations. If the pain is delayed then they are the presenting symptoms.

The objective signs of peripheral embolism are pallor, diminished temperature, decreased skin sensitivity, reduced or absent reflexes, and absent pulsation in the peripheral arteries. The color change which begins as a waxy, cadaveric pallor gradually shifts to a dark blue cyanosis in the distal part. Proximal to this there is a blotchy discoloration not unlike post-mortem lividity. In the late stages the hand or foot becomes shrunken, contracted or even mummified.

These symptoms and signs give a clear-cut picture denoting sudden ischemia. This is rarely confused with other vascular lesions, either venous or arterial. Occasionally the differentiation from spontaneous arterial thrombosis may cause trouble. Here the fact that thrombosis is usually preceded by symptoms of arterial disease gives some assistance. Moreover, the symptoms from thrombosis are apt to be more gradual in onset with slowly developing, less severe pain.

*Localization*—The exact localization of the embolus is of extreme importance to the success of embolectomy. If the clot can be freely exposed and completely removed under direct vision then the object of the operation has been accomplished. If, on the other hand, it is not found where expected, two courses are open. The first is to dissect out the artery in search of the embolus. This may necessitate an extensive dissection and even sacrifice of important structures. The second alternative is to open the artery and by means of a catheter, curette, screw-probe or forceps attempt the removal of the embolus. This intravascular manipulation may cause damage to the intima with thrombus formation. Or, this blind attempt may result in incomplete removal with a fragment of the embolus remaining to act as a focus for thrombosis. In either event the purpose of the operation is defeated.

The embolus may be located in a number of ways. The point of predilection for embolism has been shown to be at the major bifurcations of the peripheral arteries. Obstruction at any point causes obliteration of the distal pulses as well as a characteristic level of ischemia. These facts combined with a knowledge of anatomy gives a fairly accurate idea of the location of the embolus. The level of ischemia is usually from four to eight inches below the embolus. Thus obstruction of the aorta or common iliac gives a level near Poupart's ligament, that of the common femoral near mid-thigh, of the superficial femoral near the knee and of the popliteal near the mid-calf. If embolectomy is not done the line of demarcation of gangrene is always more distal than the primary level of ischemia. Occasionally the embolus can be felt as a hard lump. If this is the case a more forceful pulsation is palpable at the site of or just proximal to the swelling.

The information obtained from physical examination should serve to localize emboli in the larger vessels. In the more peripheral locations x-ray localization by arteriography may be used (Case IV). Loewe<sup>26</sup> has also

reported a case where this means was employed. Though I have sponsored a method of arteriography,<sup>5</sup> I am well aware that any foreign substance injected into an artery has the potentiality of doing harm. Yet if there is doubt about the location of the embolus the danger of its incomplete removal is felt to be greater than the risk from arteriography.

*Operative Technic*—The anæsthesia of choice for embolectomy is local infiltration or regional block. This was used in over 70 per cent of the reported cases. The primary condition causing the embolus usually results in the patient being a poor anæsthetic risk. Local anæsthesia may be used in all except aortic or iliac embolism. Here the transperitoneal approach requires general or spinal anæsthesia. If the patient's condition will not tolerate this anæsthetic burden then the retrograde removal through the femoral arteries (Key) may be tried. In fifty cases of aortic or common iliac embolism, direct removal gave 30 per cent good results as against 25 per cent for the indirect method. In all other instances intravascular probing with any instrument is to be condemned. No matter how gently it is done the intima may be sufficiently damaged to cause thrombosis.

The essential factor in the technic is to remove the embolus with minimum damage to the artery. This demands the utmost delicacy and gentleness in the manipulation. Dehydration is avoided by keeping the field covered with mineral oil or with 2 per cent sodium citrate. All instruments, sutures and needles are likewise oiled before use. The artery should be exposed enough to allow its isolation above and below the embolus. After exposure the vessel is compressed by oiled, rubber-shod "bull-dog" clamps at points well away from the embolus. Crile clamps or even a tape may be used for this purpose. The adventitia is carefully cut away from the prepared site of the arteriotomy (Fig 3). The artery is opened just above (or below) the embolus for a distance of one to two centimeters (Fig 4). The lumen is moistened with oil or with a 2 per cent sodium citrate solution. If it is desired to hold open the edges of the arteriotomy, sutures may be put obliquely through the wall (Fig 4-a). The opening may be handled by iris forceps or Bernheim's ball-tipped forceps. In general, it is wise to refrain from unnecessary handling of the wound. By means of gentle milking of the vessel the embolus is expressed from the lumen (Fig 5). Small fragments may be picked out with forceps without touching the intima. Momentary release of the proximal clamp flushes out the upper part of the channel. The distal clamp is then temporarily removed to assure the presence of back-bleeding. Following this the lumen is washed free of blood with warm Ringer's solution and oil applied. If back-bleeding is sluggish or absent from the distal portions some authors pass a probe, curette or catheter to attempt removal of the obstructing thrombus. It would appear that the manoeuvre of Lund<sup>25</sup> is preferable. This consists of exposure of the vessel at a point distal to the arteriotomy, and, after puncture with a needle, retrograde flushing with normal saline or Ringer's solution. This serves to wash out through the arteriotomy any thrombotic masses.

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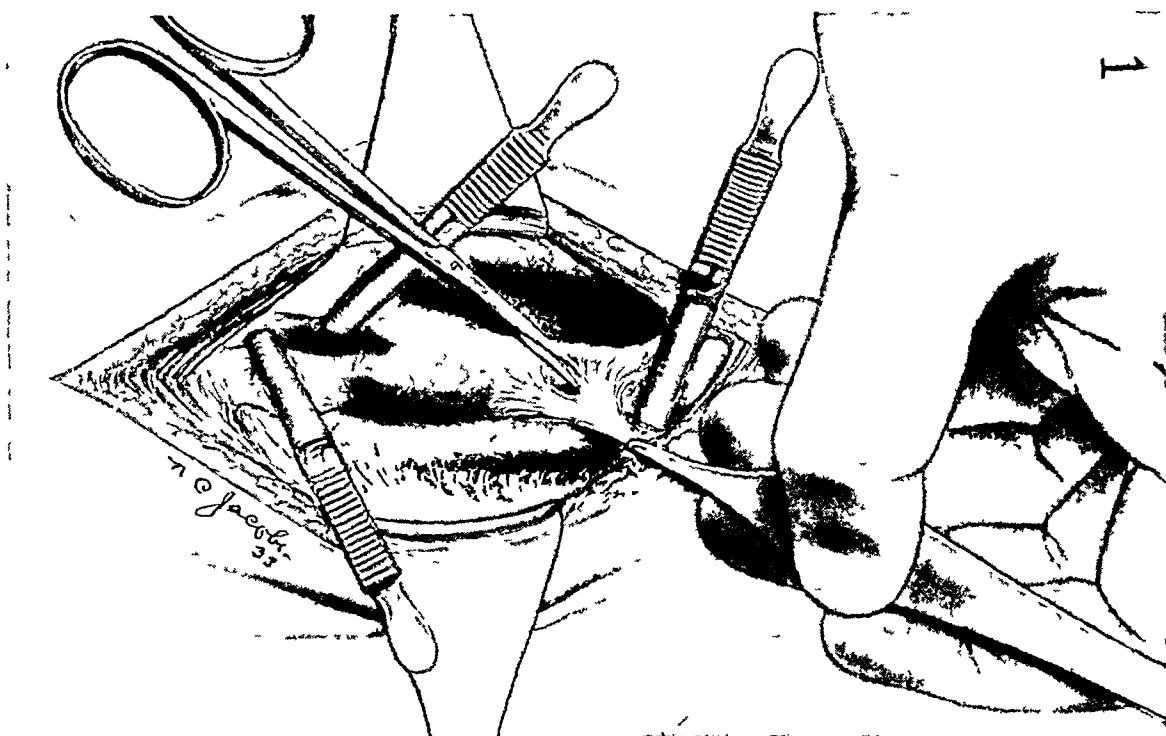


Fig 3

Fig 3—After locating the embolus the adventitia is picked up and carefully cut away from the proposed site of the arteriotomy. If this is not done strands of adventitia may be drawn into the lumen during suture and cause thrombosis. In Fig 4—The circulation is controlled by rubber shod clamps. The opening in the artery is made just above (or below) the embolus. In sect 'a' shows how traction sutures may be placed into but not through the vessel wall.

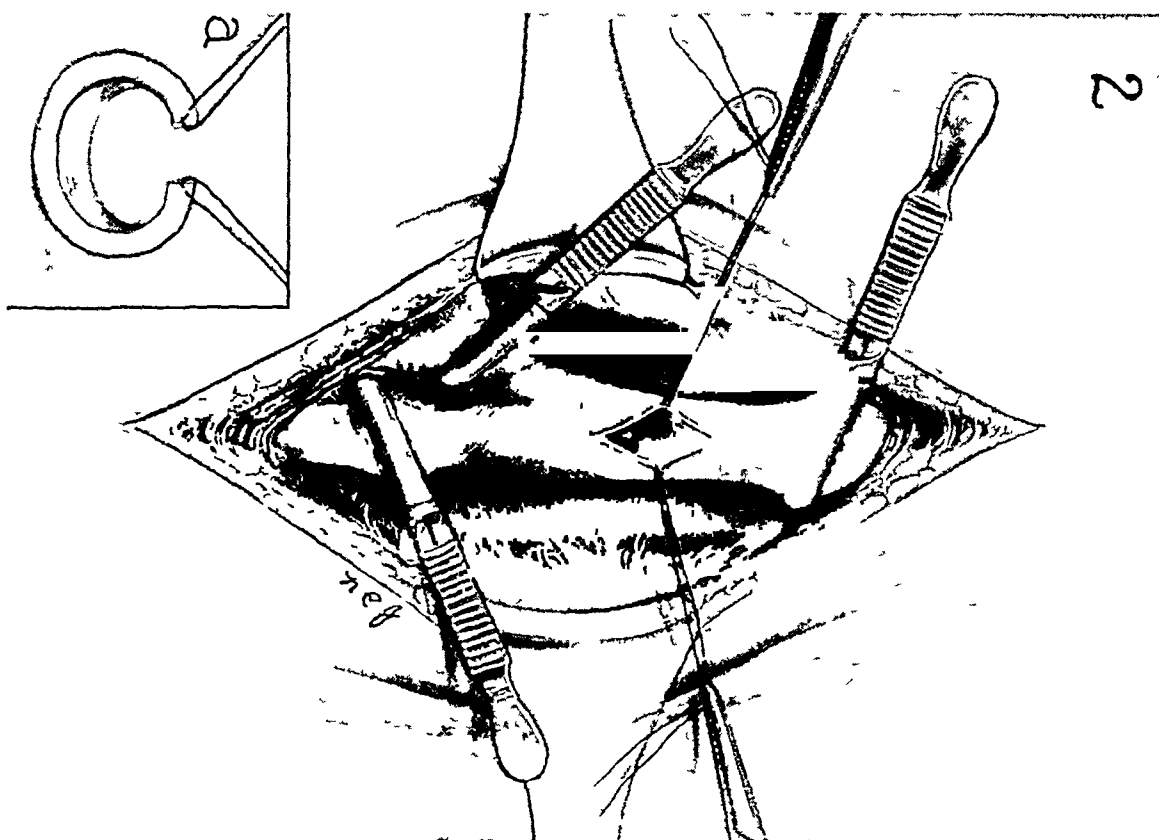


Fig 4

4

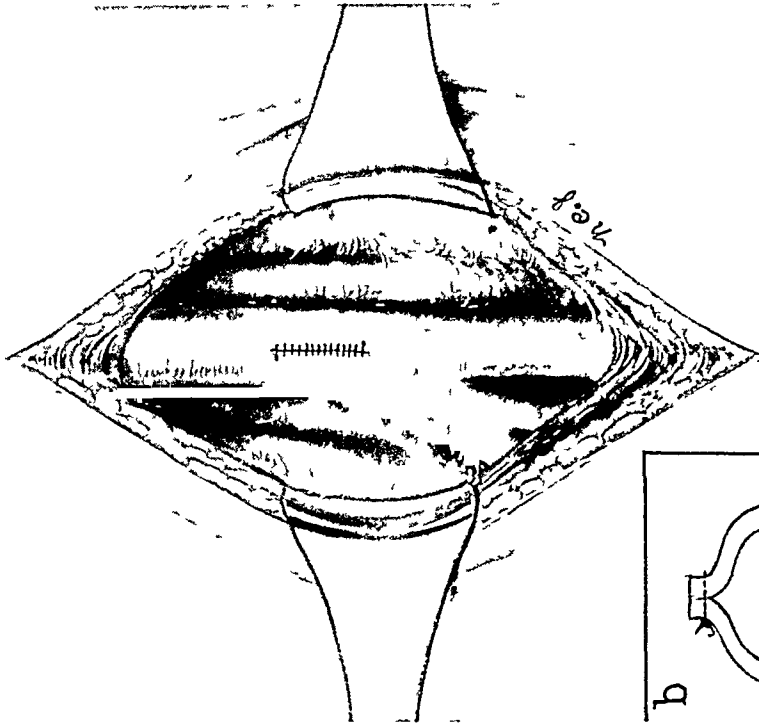


FIG 6

3

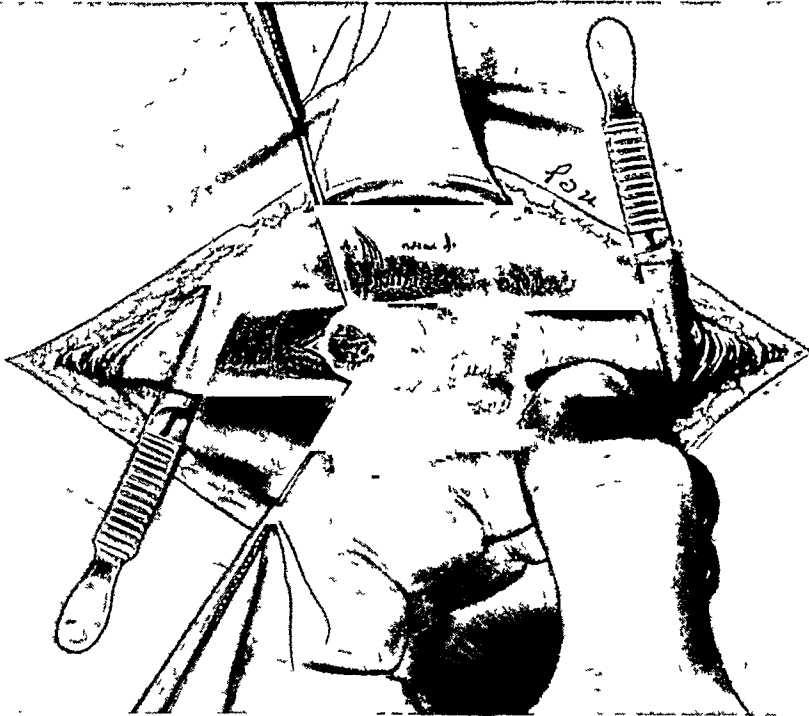


FIG 5

FIG 5—The embolus is extruded by gentle compression of the artery. After removal of the embolus all fragments should be carefully flushed out. FIG 6—The arteriotomy wound is sutured with a continuous Carrell stitch of delicate silk. A wider approximation of the intima is obtained by interrupted mattress sutures. (Insert "b") After completion of the closure the distal clamps are removed before the proximal one in order to avoid undue strain on the suture line.

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After removal of all foreign material the arteriotomy is sutured For this purpose either the continuous Carrell stitch (Fig 6) or interrupted mattress (Halsted) sutures (Fig 6-b) may be used Carrell needles threaded with split silk, well oiled, are best Arterial sutures of delicate silk on Carrell needles are also available commercially The stitches should be closely spaced with an even tension on the suture to approximate intima to intima At the completion of the closure the distal and then the proximal clamps are removed A moment's pressure with a sponge serves to stop all oozing Occasionally an additional stitch is needed to control a bleeding point Some surgeons place a second suture line outside the primary closure This is unnecessary

TABLE I  
Results of 282 Embolectomies

	1-5 hours		5-10 hours		10 hr Summary	10-15- hrs		15-20 hrs		20-30 hrs		30-48 hrs		over 48		Total	
LOCATION	Cases	Good	Cases	Good	Good	Cases	Good	Cases	Good	Cases	Good	Cases	Good	Cases	Good	Cases	Good
Subclavian	1	1	1	0	50%*											2	1
Axillary	8	4	3	1	45%	2	1	3	1	1	1	1	1			18	9
Brachial	9	4	10	5	47%	2	1			2	0	1	0	2	0	26	10
Aorta	14	4	5	2	31%	2	0	1	0	6	1	3	0			31	7
Common Iliac	14	3	14	6	32%	3	0	3	0	4	0	3	1	1	0	42	10
External Iliac	4	3	1	1	80%*									1	0	6	4
Common Femoral	44	18	25	11	42%	23	2	11	1	7	0	7	0			117	32
Superficial Femoral	4	1	1	0	20%	1	0			3	0					9	1
Popliteal	11	4	10	3	32%	3	2	1	0	1	0	2	0			28	9
Posterior Tibial	3	2			66%*											3	2
Total Number	112	44	70	29		36	6	19	2	24	2	17	2	4	0	282	85
Total Per Cent		39%		41%	40%		16%		10%		8%						

\* The small number of cases makes this unreliable

I have had on two occasions the opportunity of studying arteriotomy wounds treated in this matter Both showed a very thin layer of coagulum less than one millimetre wide sealing the wound The lumen was patent without evidence of reaction or thrombosis on the intimal surface

*Results*—Before evaluating the effect of embolectomy, one must first define what is considered a good result This is necessary since some cases have temporary improvement for a few days after which ischemia and gangrene develop Others have a satisfactory restoration of the circulation but die some time after operation either from their original disease or from embolism elsewhere These results are certainly not successful To exclude them an arbitrary interval of one month was selected as adequate to assure the permanency of the outcome Consequently a good result is defined as one



in which embolectomy restores a competent circulation for more than a month

The results of 282 embolectomies are given in Table I. These results are tabulated according to the location of the embolus and the time elapsing between embolism and operation. The information about a few additional cases was inadequate to include them in this tabulation.

Two important facts appear from these data. The first is the great importance of early operation. There is very little difference between the results of the first two five-hour periods. Combined they have an average of 40 per cent success. But after ten hours the results become progressively poorer. The average of the second ten-hour period shows 14 per cent and of the third ten-hour period 8 per cent good results. After an interval of forty-eight hours it is not worth doing the operation since no successful cases have been reported after this time. It is probable that two factors contribute to failure after the first ten hours. The first is the formation of a thrombus which obliterates the vascular channels distal to the embolus. This thrombosis may be present only a few hours after the embolism. The second factor is the damage to the intima caused by the continued presence of the embolus. This is slight at first but progressively increases so that even after a careful embolectomy a thrombus reforms at the site of embolism. These factors cannot be satisfactorily combated. They can be avoided only by early operation. Thus embolectomy is one of the most urgent of surgical emergencies.

The second fact revealed by the tabulation of results is the influence of the location of the embolus on the outcome. A summary of the per cent of successes is given for the first ten-hour period. From this it is seen that in the more superficial arteries (axillary, brachial, and common femoral) the results are better than for those in a deeper location. If the results for the first ten hours are computed for regions it is found that in the upper extremity 47 per cent, in the lower extremity 40 per cent, and in the pelvis (aorta and common iliac) 31 per cent are satisfactory.

Over half of the patients subjected to embolectomy died within a month of operation. Of the 282 cases shown in the table 149 died (52 per cent) within this time. Death was caused either by their systemic disease or by embolism to vital structures. The embolectomy played very little part in producing the lethal effect. This is shown by the fact that only 9 per cent of the group died within a day of the operation. Of these only one died on the table. Many of the remainder are stated to have died from embolism elsewhere. It is probable that the risk of embolectomy done under local anaesthesia is negligible. This risk is materially increased by the burden of a spinal or general anaesthesia.

In the tabulated group, 122 patients survived for twenty-four hours but died within a month of operation. Of these, thirty-five or 12 per cent had a satisfactory circulation in the extremity operated upon. Of this number twenty-eight or 10 per cent had the embolus removed within ten hours.

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This percentage (10 per cent) may be added to that of the permanent good results (40 per cent) to show the relative effectiveness of embolectomy in restoring the circulation

*Result of Procedure Other than Embolectomy*—There are several other methods of treating peripheral embolism which require discussion

*Conservative Measures*—Under this heading are grouped those procedures employed when a course of "watchful waiting" is decided upon. They consist of general supportive measures as well as local treatment. This latter consists of rest, elevation and the application of heat. If gangrene occurs amputation is delayed until a line of demarcation forms. There is no doubt that embolism of a major artery will result in gangrene and loss of limb in the majority of instances. Thus, these conservative measures have now been superseded by embolectomy in all early cases. In those seen late the conservative attitude is still justifiable.

*Massage*—Lindstrom is the foremost advocate of massage in the treatment of embolism of the extremities. By massage an effort is made to break up or dislodge the embolus and force it down into the smaller branches of the arterial system. This may leave enough channels uninvolved to assure collateral circulation. On the other hand, the manipulation may forcibly impact parts of the embolus into necessary arterial segments. Because of its uncertainty massage has little appeal when contrasted to early, complete removal of the embolus by arteriotomy. But the results in a few cases are not bad. In twelve of twenty instances of embolism gangrene was avoided. Key collected eighteen of these in sixteen patients. Mason<sup>29</sup> has recorded a case and we have seen one case in this clinic. This latter patient apparently had embolic occlusion of the popliteal artery. By his forceful massage the embolus was pushed into the anterior tibial branch. The patient recovered without gangrene but the functional capacity of the limb was slight. This result is not uncommon for though gangrene is avoided yet a part of the arterial system is occluded.

*Vein Ligation*—Therapeutic venous obstruction has been applied in the treatment of embolism under two circumstances. Its first use is as an addition to conservative treatment. It is difficult to evaluate the effect here but it certainly is not a substitute for embolectomy. We have had experience with three cases. All of these were seen too late for operative removal of the embolus. In two, slight improvement occurred, but in the third no change was noted and gangrene developed. Vein ligation is no panacea. It deserves consideration only in the late case which is on the verge of circulatory failure. Under such conditions its use would appear justifiable.

The other circumstances where vein ligation has been used is as an adjunct to embolectomy. Some authors tied the vein after removal of the embolus. The reasoning applied is apparently that the benefit of the vein ligation is derived in case the embolectomy fails. I have never done this. Perhaps it is justifiable but I have felt that all efforts should be directed towards careful complete removal of the embolus. This is the important

issue In case this fails then it is a simple matter to reopen the wound and ligate the vein This was done in Case II It did not make a particle of difference, as far as could be observed, in the outcome

*Arteriotomy*—The excision of the artery with its contained embolus and thrombus has been advocated The basis for this is the lower incidence of gangrene from ligation than from embolism at the same level If the thrombotic process subsequent to embolism can be kept from plugging the distal arteries, then collateral circulation may save the limb This is not an unreasonable hypothesis Its application will depend upon the known incidence of gangrene from ligation of the particular artery involved It should not be considered as a substitute for embolectomy in favorable cases But in those seen late, it might be used with benefit

## SUMMARY

(1) The operation of embolectomy deserves a wider use This may be brought about if surgeons interested in the subject acquaint their colleagues with the possibilities of the procedure

(2) As a direct result of close cooperation with the attending physician nine early instances of embolism of the extremities were seen within the past year Two of these were not operated upon because of serious embolism elsewhere Seven embolectomies were done in six cases Of these two died, two developed gangrene and three were successful These cases are reported

(3) 296 cases of embolectomy have been recorded in the literature up to July, 1932 A study of all reported cases has been made

(4) It was found that the embolus came from a primary heart disease in 69.2 per cent and from post-operative states in 13 per cent of the cases Various etiological conditions accounted for the remainder

(5) Almost without exception the embolus lodges at a major bifurcation of the arteries of the extremity The most common locations are at the division of the common femoral, common iliac, brachial, aorta and popliteal arteries

(6) The symptoms of embolism of the extremity are excruciating pain, numbness, coldness and paralysis of the part involved The signs consist of pallor, diminished temperature, decreased skin sensitivity, reduced or absent reflexes and absent pulsation in the peripheral arteries

(7) The pre-operative localization of the embolus and the operative technic are discussed

(8) Aside from the careful technic, the results from embolectomy are shown to be dependent upon exact localization and early complete removal of the embolus Operation within ten hours gives 40 per cent successful results Delay mitigates against a favorable outcome

(9) Over half (52 per cent) of the patients subjected to embolectomy died within a month of operation This materially lowers the per cent of good results from the operative procedure Yet the embolectomy usually

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plays no part in the lethal result. The high mortality is due either to the primary systemic disease or to embolism to vital structures.

(10) In embolism of the arteries of the extremity the ideal to be achieved is early, complete removal of the embolus with restoration of the continuity of the circulation.

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# THE TRENDELENBURG OPERATION FOR PULMONARY EMBOLISM

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SINCE Kirschner,<sup>1</sup> in 1924, reported his successful operation for pulmonary embolism, there has been a marked increase in the number of such operations performed in European clinics. The chief contributions in this field have been by Meyer,<sup>2</sup> Nystrom,<sup>3</sup> Giertz and Crafoord,<sup>4</sup> and Crafoord,<sup>5</sup> and they have made important modifications of the original operation devised by Trendelenburg,<sup>6</sup> in 1908. It is remarkable that no attempts have been reported from American clinics. Matas<sup>7</sup> has said "It is hoped that the teachers in charge of the schools of operative and experimental surgery will take heed of this notable advance and make the practice of embolectomy and of the Trendelenburg operation an obligate part of the curriculum in the laboratories of experimental surgery." Willy Meyer and Lilienthal<sup>8</sup> recommended intensive training of the hospital staff in this procedure.

Two unsuccessful cases are reported here with the feeling that since we frequently learn more from our mistakes than from our successes these lessons should be passed on. It is difficult to evaluate a comparatively unproven procedure such as this unless all cases are described in detail. It is only in this way that the diagnosis, the indications, and the technic may be clarified and perfected, and the unsuccessful as well as the successful cases will determine whether pulmonary embolectomy will be generally accepted or will be found unworthy and discarded.

The incidence, occurrence and etiology of pulmonary embolism have been adequately discussed in recent literature. The papers of Petrén,<sup>9</sup> Hosoi,<sup>10</sup> and Giertz and Crafoord<sup>4</sup> are outstanding. Hosoi<sup>10</sup> states that the incidence varies from 0.12 to 0.67 per cent, as reported by various authors. Harvey<sup>11</sup> states that massive pulmonary embolism is fatal in about one-half of 1 per cent of all cases operated upon, and that in operative procedures in the lower abdomen the mortality from this cause rises to two per hundred, a seemingly irreducible minimum, composing about one-quarter of fatalities from all causes. He considers that operative removal of the embolus from the pulmonary artery is impracticable and that it is more important to devise methods to prevent the occurrence of an embolus. An irreducible minimum of 2 per cent in lower abdominal operations, however, should lead the surgeon to restorative as well as to preventive efforts. Some authors believe that the condition is becoming increasingly frequent, but this may be apparent only because of better diagnosis.

The diagnosis may be self-evident or it may be difficult. The usual syn-

drome is sudden collapse, pallor, lividity of lips and nails, loss of pulse and rapid difficult respiration. Substernal pain and the sensation of impending death may be present. Cyanosis and unconsciousness may ensue before death. In the series of Giertz and Crafoord,<sup>4</sup> the most frequent symptoms in twenty-three cases were

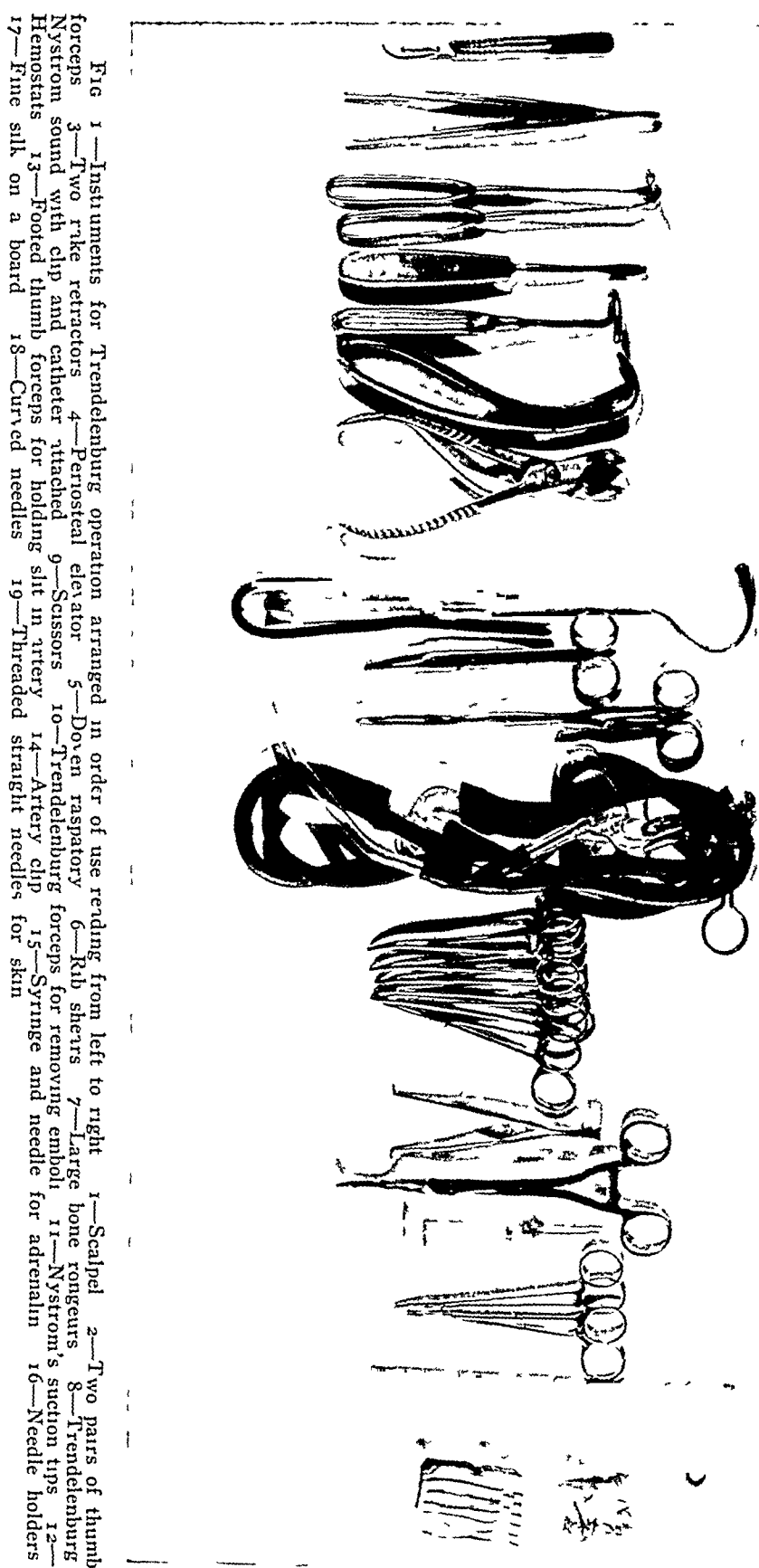
<i>Sudden onset of symptoms without any forewarning</i>	23 cases
High, soft, finally imperceptible pulse	23 cases
Marked pallor	18 cases
Unconsciousness	17 cases
Livid lips, slight cyanosis	12 cases
Altered respiration	23 cases
Anginoid pain	20 cases

The limited time is the chief obstacle to diagnosis. Other conditions may mimic pulmonary embolism. Nystrom<sup>3</sup> operated upon a patient dying from uræmia and cites other cases in which the diagnosis was incorrect. The following case illustrates such a mistake in diagnosis. This patient had all the symptoms tabulated above except anginoid pain.

F. H., a white male of forty-three years, had a badly swollen and infected amputation stump of the left thigh. The temperature had been as high as 39.7° C., but on the fourth and fifth days post-operative it did not rise above 38.2° C. The pulse rate ranged between 90 and 120, with respirations of 20. His condition seemed satisfactory and though the stump was very œdematous it was draining well. He was somewhat restless the afternoon of the fifth day but stated that he felt well except for some pain in the stump. When he finished his evening meal at 5.30 P.M. the nurse noted that he seemed to be in good condition. At 5.40 he called her, was moaning and said that he was going to die. His skin was ashen and mottled, the nails were cyanotic, the respirations were labored, 34 per minute, and his pulse was very weak with a rate of 144. When I saw him fifteen minutes later the pulse and respirations were the same. Systolic blood-pressure was obtained at 70 with no clear diastolic. He complained of no pain but still had the sensation of impending death. The hands and nails were cyanotic, the skin elsewhere was pallid and moist.

He was taken immediately to the operating room and prepared for the Trendelenburg operation and for ligation of the left common iliac artery. The pulse became imperceptible, the heart rate being about 150 by stethoscope, with very weak heart sound. The systolic beat was obtained at 35. Respirations became more labored, cyanosis was marked and the patient became unconscious.

Incision for the Trendelenburg operation was made at 6.30 without reaction on the part of the patient, no anæsthetic being necessary. A left parasternal incision was made from the upper border of the second costal cartilage to the lower border of the fourth, carried through the skin, subcutaneous tissue and pectoralis major muscle exposing the costal cartilages. The soft parts were retracted laterally, the Doyen rasp was introduced around and beneath the third costal cartilage close to the sternum, and the intercostal muscles were pushed laterally, according to the method of Meyer, striking a cleavage plane outside the pleura. A section of costal cartilage, two inches in length, was rapidly removed and a similar procedure was carried out on the fourth and second costal cartilages. About one-third the width of the sternum was removed with a large rongeur. This exposed the pleura and the pericardium. The heart could be seen beating fairly well so that it was possible to proceed slowly and carefully from this point onward. A finger was introduced downward into the triangle of safety and the finger swept upward, pushing the pleura away from the pericardium to the upper limit of the wound.





This was accomplished very easily without injuring the pleura. The pericardium was picked up and incised from the lower angle of the wound well up toward the base of the heart. The thymus, which overlay the upper portion of the pericardium, was damaged during this procedure. The pericardial cavity was smooth and glistening and contained probably ten cubic centimetres of pale, straw-colored fluid. The heart was beating feebly, about 120 per minute. The Trendelenburg sound was introduced through the great transverse sinus, the rubber tube attached and drawn around the aorta and pulmonary artery, bringing them up into the wound. A longitudinal incision, 15 centimetres long, was made in the pulmonary artery just distal to the valve. The operation from the time of incision to this point had taken approximately 190 seconds. Trendelenburg forceps were introduced into the pulmonary artery and the two main branches on both right and left sides easily found. No embolus was withdrawn or felt. The flow of blood from the pulmonary artery was good on relaxation of the tube. The heart beat had become more feeble, the tube was, therefore, relaxed and the opening in the artery held with the fingers to allow the heart to recover somewhat. There was slight improvement in the heart action after the application of hot saline solution, massage and the injection of one cubic centimetre of adrenalin into the right auricle. The tube was again tightened and the arteries were re-explored, the upper and lower branches on both sides being again entered without finding a clot. The heart action was becoming more and more feeble and did not respond to a second injection of adrenalin into the left ventricle or to adrenalin dropped on the surface. The anæsthetist had reported increasing cyanosis and more labored respiration, and blood coming from the pulmonary artery was quite dark. Respirations ceased at 6.43. The heart was delivered out of the wound. It was flabby, anæmic and soft, but no lesions of the coronary vessels could be demonstrated.

Autopsy was not obtained.

It is a common idea that death from pulmonary embolus is almost immediate. Trendelenburg<sup>6</sup> realized the incorrectness of this conception and observed that in at least one-half the cases a minimum of fifteen minutes would be at the disposal of the surgeon. Giertz and Crafoord<sup>4</sup> found that of twenty-seven cases of pulmonary embolism the diagnosis was not established until after death in four instances. Three cases were operated upon, with two recoveries. Of the remaining twenty, they feel that thirteen cases would have been possible cases for operation and that in another four the operative possibility was open to question.

In the twenty cases the time from onset of attack until death was as follows:

Less than ten minutes	3
Ten to twenty minutes	7
Twenty minutes to one hour	4
Over one hour	6

We have for the past year kept a set of sterilized instruments in the operating room for the Trendelenburg operation. They are arranged in a pocketed roll in the order of use from left to right (Figs 1 and 2). The house staff and head nurses have been taught the cardinal signs of embolism and there are at most times surgeons within easy reach who are capable of performing the operation.

The *technic* has been practiced on cadavers and is remarkably easy to master. We have used a combination of the methods and instruments of Nystrom and Meyer, as modified from Trendelenburg. A straight incision is made along the left side of the

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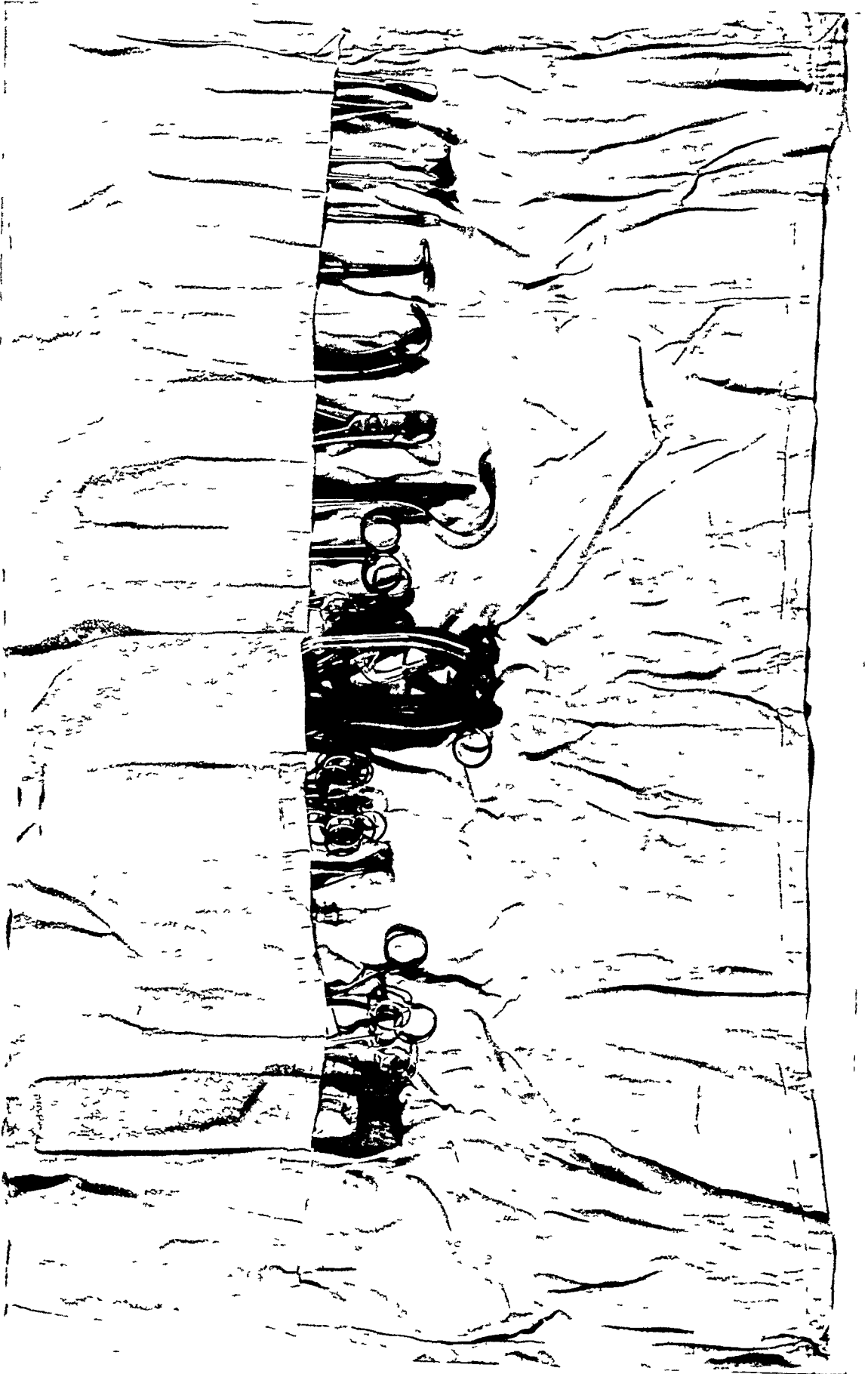


Fig 2—Instruments are kept in a sterilized roll and are handed out in order from left to right

sternum from the upper border of the second to the lower border of the fourth costal cartilages, dividing the origin of the pectoralis major. A Doyen raspatory is passed about the third cartilage close to the sternum and pushed sharply to the left according to the method of Meyer. This strips the soft tissues from the rib and enables one to do a rapid resection without injuring the pleura or internal mammary artery as the instrument invariably enters the proper plane of cleavage if correctly inserted. This is easier, quicker and safer than the usual subperiosteal resection. The second and fourth cartilages with a bit of rib are similarly resected and from one-fourth to one-third the width of the sternum is removed with large rongeurs. The forefinger is inserted at the lower angle of the wound into the triangle of safety of Voinitch-Sianojentsky and swept cephalad, easily stripping the pleura laterally from the pericardium. The pericardium is picked up and opened with knife or scissors. The opening may be enlarged by the fingers or by cutting. In the latter case there is some chance of injuring the thymus.

Nystrom's Trendelenburg sound is passed from left to right through the great transverse sinus behind the aorta and pulmonary artery, the rubber tube with its clip attached to the sound and drawn back. Gentle traction on the tube lifts these vessels from the depths of the wound. The pulmonary artery is usually easily identified, although the aorta has been opened by mistake.<sup>3</sup> The longitudinal incision in the artery should be placed with care to avoid injury to the orifice of the valve. An incision of 1.5 centimetres is sufficient. The rubber tube is relaxed to allow clots in the heart to be flooded out, then the tube is tightened and the blood is rapidly removed from the pericardium. Gentle traction is important as there have been instances of trauma from the tube being pulled too tightly. It is sufficient to use just enough traction for exposure as the hemostatic effect is probably unnecessary.

With the Trendelenburg forceps the pulmonary branches are explored, first on one side and then on the other. The right main branch extends toward the right axilla and the left directly backward and there is usually little difficulty in finding them. If the emboli are soft and friable the suction tips of Nystrom<sup>3</sup> may be useful, but the clot usually comes out in two or three large pieces. If difficulty and delay are experienced at this point it is a good plan to compress the slit in the vessel with the fingers and relax the traction tube to allow the heart to recover somewhat before making another attempt at extraction, as suggested by Trendelenburg.<sup>6</sup> It is stated<sup>6</sup> that forty-five seconds is the limit of time during which the pulmonary artery may be completely compressed. This is open to question, however, and Nystrom<sup>3</sup> believes that under favorable circumstances complete suspension of the circulation for nearly two minutes may not be incompatible with life. If the suction tip has been used, the vessel should be flooded with blood to drive out air before closure. The slit in the vessel is held up by "footed" thumb forceps, the artery clamp applied, and the lips of the incision closed with a continuous fine silk suture. If necessary, the clamp may be left on while any necessary resuscitating measures are taken, such as cardiac massage, intracardiac injection of adrenalin or artificial respiration, before suturing the vessel. An opening should be left in the pericardium to prevent tamponade from accumulation of fluid.

In the following case all the elements necessary for success were present, namely, an otherwise healthy patient, correct diagnosis, abundance of time, proper equipment, and an adequately trained team of operator, assistants, nurses and anæsthetist. The operation was delayed too long, however, in the hope that recovery might ensue without operation. A less conservative course should have led to success.

E. Z., a white married woman of twenty-four years. Her past history was irrelevant except for three normal pregnancies and a gynecological procedure in August, 1931. At that time a perineorrhaphy, uterine suspension, and appendectomy were performed. The post-operative course was uneventful. A history of gall-bladder disease began about

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three years ago with attacks of sharp epigastric pain after meals. This pain radiated through to the back and lasted about twenty minutes. It was sometimes partially relieved by food or soda. She had had typical biliary-tract indigestion. Attacks continued at shorter intervals and for the two weeks before admission had occurred daily, lasting eight to ten hours. The patient had never been jaundiced or noticed clay-colored stools.

The physical examination showed a well-nourished and well-developed female of twenty-four years, whose heart was slightly enlarged to the left with a soft systolic murmur, heard best at apical and aortic regions. The head, neck, throat and lungs were normal. The abdomen was rounded, and there was a small tender mass palpable at the tip of the ninth right costal cartilage. The liver did not seem to be enlarged. There were no other masses, tenderness or muscle spasm in the abdomen. A healed mid-line lower abdominal scar was present. The pelvic and rectal examinations and examination of the reflexes and extremities showed nothing remarkable. In the cholecystogram there were multiple negative shadows diagnostic of calculi. On admission the temperature was  $38.2^{\circ}\text{C}$ , pulse 110, blood-pressure 110/80, respirations 20. The urine was normal except for an occasional white blood-cell. The white blood-cell count was 13,600. The hæmoglobin was 60 per cent.

May 27, 1932, cholecystectomy was carried out through the usual right paramedian incision. The gall-bladder was pale, œdematous, thick-walled and adherent. It contained cloudy, pale gray fluid which showed no organisms on culture. The pathological report on the gall-bladder was acute cholecystitis and cholelithiasis. There was nothing unusual about the conditions found at operation. The cystic duct and cystic artery were ligated separately, the gall-bladder bed was closed and the operative field drained by two cigarette drains. The immediate post-operative condition was good. The temperature went as high as  $39.6^{\circ}\text{C}$ , with a pulse of 120 following operation, but gradually came down in the course of five days to  $37.5^{\circ}\text{C}$ . The pulse came down to 80 and the respirations ranged between 20 and 24. Her bowels moved on the third day. The fluid intake ranged from 2,150 cubic centimetres to 3,700 cubic centimetres. The white blood count dropped to 7,200 on the fourth day. The sutures were removed on the fifth day. The wound was in good condition and there was no undue tenderness or spasm of the abdomen. There had been no swelling or pain in either leg.

At 8 00 P M on the fifth day the temperature was  $37.5^{\circ}\text{C}$ , pulse 80, respirations 20. At 10 30 P M the patient awakened suddenly, sat up in bed and complained of extreme shortness of breath. The pulse was weak, and respirations extremely rapid. She was seen by the interne at about 10 40. The pulse at that time was 140 and almost imperceptible. The blood-pressure was 70/60 and respirations 40. I saw her at 11 10. At this time the skin was cold and clammy, the face pallid, lips and finger-nails somewhat cyanotic and respirations rapid and labored. The blood-pressure was 80/60. The pulse remained almost imperceptible. Cardiac rate by stethoscope was about 140. The sounds were clear and strong and there was a good cardiac impulse palpable. The costal margins moved equally, and no shift of the mediastinum could be made out. The lungs were clear anteriorly and laterally, posterior examination not being carried out. Nothing remarkable was found in the abdomen. There was no swelling of either lower extremity and no tenderness along the course of the great veins. A diagnosis of pulmonary embolus was made.

The patient was taken immediately to the surgical floor and placed in a preparation room. Her only complaint was of extreme difficulty with respiration. She stated that she had no pain and did not feel a sense of impending disaster. On account of dyspnoea and cyanosis of lips and nails, inhalation of oxygen was started through an anæsthetic mask. This brought considerable relief. Observations of pulse, respirations and blood-pressure were taken at intervals of five minutes from this time on. There was very little variation in these readings. Respiration ranged from 48 to 60, cardiac rate from 106 to 140, blood-pressure from 80/70 to 98/80. Her skin became warm and dry. The temperature at 2 00 A M was  $39.2^{\circ}\text{C}$ , at 5 00 A M  $39.8^{\circ}\text{C}$ . Her clinical condition

showed little change except that as the night wore on she demanded increasing quantities of oxygen. At first oxygen could be left off for several moments with little discomfort. After 3 00 A M, however, continuous administration of large quantities was necessary. At about 4 00 A M she complained of pain in the chest anteriorly in the mid-line, and an hour later localized this in her heart. Cardiac impulse continued to be forceful as determined by palpation and auscultation. She had been seen by members of the Medical Service at 1 00 A M and they agreed with the diagnosis of pulmonary embolus. At 6 00 A M a portable X-ray plate of the chest was taken which showed an indefinite shadow of density at the right base running into the hilus. The lower half of the left chest contained a shadow of even density which, however, was not dense enough for pneumonia. At about 6 00 o'clock the blood-pressure apparatus was changed from the left arm to the right because of pain and numbness from the continued application. The blood-pressure was imperceptible from this time on. Cardiac rate was 130, respirations 50 to 60. The cardiac impulse was good, although the peripheral pulse was imperceptible. The patient had been entirely conscious, oriented and cooperative throughout the night. At 6 30 A M one-sixth grain of morphine was given for pain. At 7 00 A M respirations suddenly ceased, cardiac impulse could not be heard or felt, and the pupils became widely dilated.

The equipment and the personnel for the Trendelenburg operation had been kept in readiness during this time. The patient was hurriedly wheeled in bed across the hall



FIG 3—Emboli removed from Case II. The longer clot was from the left pulmonary branches and the shorter clot from the right.

into the operating room, scrubbed and draped, and an incision was made along the left border of the sternum, from the upper margin of the second costal cartilage to the lower margin of the fourth. The lateral edge of the incision was retracted and the second, third and fourth costal cartilages with muscles were removed according to the method of Meyer. The heart was immobile. The left pleura was reflected laterally by placing the finger in the triangle of safety and sweeping upward and to the left. This was accomplished easily without tearing the pleura. The pericardium was picked up, incised and the incision spread with the fingers for a distance of about eight centimetres. The heart remained motionless and no respirations occurred. Meanwhile, carbon dioxide and oxygen were being given rhythmically under pressure. The Trendelenburg sound was passed through the great transverse sinus from left to right, the aorta and pulmonary artery drawn forward with a rubber tube, and the pulmonary artery opened by a longitudinal incision 1.5 centimetres in length just distal to the valve. There was a gush of dark blood from the opening. The Trendelenburg forceps inserted into the right main branches brought forth one cylindrical clot which later was found to measure 12.5 centimetres in length and 7 millimetres in diameter (maximum), from the left main branches a clot twenty-eight centimetres by eight millimetres was obtained (Fig 3). The opening in the vessel was temporarily closed by grasping it with the fingers. The rubber tube was released and the heart massaged. Regular cardiac contractions of fairly good strength resulted. The entire time from the cessation of respiration and

cardiac action was something less than ten minutes, the time from the skin incision less than three minutes. The pulmonary artery and aorta were lifted by the rubber tube for perhaps forty seconds. Fairly well maintained contractions having been obtained, the opening in the pulmonary artery was secured with the Trendelenburg clip. The heart beat had been fairly forceful and the tone of the cardiac muscle seemed comparatively good. The beat, however, became weaker and finally ceased. Contractions were restored by massage, and the intracardiac injection of adrenalin together with the application of hot saline solution to the surface of the heart. This procedure was gone through with several times until cardiac contraction finally ceased at 8 15 A M. Artificial respiration and carbon dioxide oxygen therapy had been continued during this time. The opening in the pulmonary artery was closed with a continuous, fine silk suture at about 8 o'clock. This closure was not quite tight and leaked blood with each contraction of the heart so that a second single reinforcing suture was placed. The myocardium had become progressively weaker, both in regard to strength of contraction and interval tone, the heart finally stopping in a state of complete dilatation and relaxation. Permission for autopsy was not obtained.

Failure of the Trendelenburg operation in this case, which should have been ideally favorable for the procedure, was, I believe, due to the fact that oxygen was administered over a long period of time, improving the clinical appearance and masking the true condition of the patient until the overburdened right heart had lost all recuperative power after pumping against an almost completely obstructed pulmonary system for over eight hours. Operation was not carried out earlier because the patient's unchanged appearance led me to believe that she might recover spontaneously. If oxygen had not been administered her apparent condition would have become so bad that we would have been forced to operate shortly after the onset. I cannot help but feel that operation undertaken before her myocardium and respiratory centres had become exhausted would have been successful.

#### SUMMARY AND CONCLUSIONS

(1) Two unsuccessful cases of pulmonary embolectomy are reported. The first case illustrates some difficulties of diagnosis, the second the results of a too conservative attitude.

(2) This procedure, if carefully studied as to diagnosis, indications and technic, is the only hope of saving quite a large class of patients, since prophylactic measures directed against the incidence of pulmonary embolism have so far shown themselves of no avail.

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# ADVANCES IN THE DIAGNOSIS AND TREATMENT OF THROMBO-ANGIITIS OBLITERANS

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UNTIL recent years, thrombo-angitis obliterans has been a relatively obscure disease and its differentiation from other types of peripheral vascular disturbances was difficult. Its treatment was chaotic, and amputation of the extremity was resorted to very early in its course. With the advent of a better understanding of the pathology of this disease and modern methods in its diagnosis, the treatment was placed on a firmer physiological basis.

The condition was first described by von Winiwarter,<sup>1</sup> in 1879. Buerger,<sup>2</sup> in 1908, was the first to interpret accurately its pathology as an inflammatory condition involving the arteries and deep veins of the extremities and resulting in thrombus formation. As the acute inflammation subsides and the condition becomes chronic, the thrombi become organized and canalized. He suggested the term thrombo-angitis obliterans as a descriptive name for the disease. Since then nothing new has been added to our knowledge of the pathology except that the disease is not confined to the vessels of the extremities but is a generalized condition. Cases of thrombo-angitis obliterans involving the vessels of the heart,<sup>3</sup> brain,<sup>4</sup> and gastro-intestinal tract<sup>5</sup> have been reported.

The etiology of thrombo-angitis obliterans is still obscure. Although a large proportion of the cases occur in Russian and Polish Jews, the condition is not confined to that race and has been found in Japanese, Norwegians, Germans, Swedes and even in Negroes. It is a disease of young men and is rare in females. Buerger<sup>6</sup> believes that it is an infectious process. In his experiments, the paravascular implantation of clots from cases of acute thrombo-angitis obliterans was followed by the development of typical lesions in the apparently healthy ligated veins of the inoculated persons. Rabinowitz<sup>7</sup> found a Gram-negative motile bacillus in a small number of cases. Horton and Dorsey<sup>8</sup> obtained a Gram-positive pleomorphic streptococcus in nine cases and a green-producing streptococcus in two cases. Their results after injecting these organisms into rabbits were inconclusive.

It is generally believed that the use of tobacco is a factor in thrombo-angitis obliterans. Just how important it is cannot be stated, but Barker,<sup>9</sup> of The Mayo Clinic, who studied the records of 350 cases of thrombo-angitis obliterans and of 350 controls, believes that nicotine predisposes to recurrences. According to Silbert,<sup>10</sup> "Whatever the underlying cause, prolonged smoking is the immediate causative factor in the production of the disease." Willy Meyer<sup>11</sup> believes that sufficient amounts of nicotine, pyridin, cyanic hydrogen, carbon monoxide and other poisons are contained in tobacco.



smoke to cause secondary vascular changes. However, Jablons and Koyano have reported the condition in non-smokers. The tobacco factor must be carefully evaluated as occasionally smoking is initiated and often accentuated when the patient experiences pain and cannot sleep.

*Diagnosis*—The symptom complex of intermittent claudication, coldness of the toes and feet, trophic changes in the skin and nails and beginning gangrene of the extremities in a man between the ages of twenty and forty-five years is very suggestive of thrombo-angitis obliterans.

The disease is frequently preceded by a migrating phlebitis of the superficial veins of one or both lower extremities. By some clinicians this finding is considered pathognomonic of the disease. It is followed, usually in several months, but sometimes in several years, by the insidious development of cramp-like pain in the arches and soles of the feet and in the lower parts of the legs during cold weather and on walking moderate distances. The patient soon finds that the pain disappears when he is at rest with the feet pendent. These symptoms resemble closely those of fallen arches, and occasionally cases are treated for some time on that basis or for so-called rheumatism before the true condition is recognized. The extremities become cold and the pain becomes more severe and more frequent. It is present after walking shorter and shorter distances and assumes the typical character of intermittent claudication. Finally the patient has severe and sometimes lancinating pain in the extremities even while at rest. About 95 per cent of the cases have symptoms referable to the lower extremities. Although in about 30 per cent of the cases there is involvement of the vessels of the upper extremities, which is found on examination, the patients seldom have symptoms in those limbs. Sometimes a chronic ulcer on a poorly healing infection of a toe dating from an injury or from the removal of a toenail is the only complaint which brings the patient to the physician.

As the condition advances, parts of the extremities finally become cyanotic and gangrenous, first the toes and then the feet. However, the disease does not always become progressively worse but spontaneous remissions occur. They may last for months and even years, and frequently a sufficient collateral circulation is established to cause a complete cessation of the symptoms.

On examination in the early cases one usually finds only a slight cyanosis and coldness of one or more toes. In the later stages the feet and sometimes the leg may be cold and the cyanosis may involve the whole foot. It is often patchy and may vary from pink to deep purple. Samuels<sup>12</sup> has recently called attention to the almost constant presence of plantar ischæmia in thrombo-angitis obliterans. There may be present trophic changes as abnormally large callosities and linear breaks in the skin and a marked thickening of the nails of the toes. Pulsations in the arteries are usually present in the early stages but as the condition progresses the dorsalis pedis and the posterior tibial arteries cease to pulsate, and in the late stages one cannot feel even the popliteal arteries. The gangrene which one finds in the very last stages is usually a dry type frequently involving the skin of one or more toes.

## THROMBO-ANGIITIS OBLITERANS

As it advances the deeper structures and finally the foot and the leg become affected. Preceding the gangrene there is always an area of deep cyanosis and hard œdema.

Buerger<sup>13</sup> describes a simple test which is a great aid in the diagnosis and differentiation from other conditions. With the patient in the supine position, elevation of the extremity  $45^{\circ}$  to  $90^{\circ}$ , in cases of thrombo-angitis obliterans, results in a marked ischæmia in thirty seconds to three minutes which may involve several toes or parts of the foot or leg. Lowering the extremity  $45^{\circ}$  to  $90^{\circ}$  below horizontal results in a marked reactionary rubor in the same areas. Buerger explains the latter phenomenon as a reflex dilatation of the capillaries of the skin after being emptied on elevation due to the inability of the collateral circulation to force blood up against gravity. This reaction is present to a lesser degree in arteriosclerosis of the vessels of the lower limbs. In early cases this is a particularly valuable sign for it may be present long before the chronic cyanosis develops.

Another valuable aid in diagnosis brought out by Buerger is the angle of circulatory sufficiency. "The estimation of the angle of circulatory sufficiency is based on the supposition that the normal limb, when elevated so as to be perpendicular to the horizontal plane, that is  $180^{\circ}$ , still retains most of its color. When the circulatory mechanism is defective, and the limb is elevated to the vertical, a variable degree of blanching of the foot occurs. If the leg is then gradually depressed, *the angle at which a reddish hue returns* (angle of circulatory sufficiency) will be found to vary considerably. In some cases it will be necessary to depress the limb to the horizontal before evidences of return circulation are manifest. The angle of circulatory sufficiency would then be  $90^{\circ}$ . If the reestablishment of visible circulation in the skin necessitates depression below the horizontal, the angle will be correspondingly less than  $90^{\circ}$ . In many cases of arterial disease, the estimation of this angle is a valuable adjuvant, not only in the recognition of the extent of the circulatory disturbance, but also in the prognosis."<sup>13</sup> In thrombo-angitis obliterans the angle of circulatory sufficiency is seldom above  $90^{\circ}$  and most often is about  $60^{\circ}$ .

Brown, Allen and Mahorner,<sup>14</sup> in a report based on the study of over 300 cases at The Mayo Clinic, state that a careful analysis of the symptoms and the ordinary clinical findings are sufficient to make a diagnosis in about 95 per cent. of the cases. However, a description of the recent advances in the instrumental and other aids in the diagnosis and prognosis of thrombo-angitis obliterans lies within the scope of this review.

Variations of the surface temperature usually occur in vascular diseases of the extremities. This can be determined roughly by palpation with the palm of the hand, but more accurate temperature determinations may be made by means of the thermocouple galvanometer or by means of the skin thermometer which is more practical and accurate enough for ordinary purposes. Normally the temperature of the skin in a room at  $22^{\circ}$  to  $26^{\circ}$  C. varies from  $33^{\circ}$  to  $35^{\circ}$  C. in the region of the thigh to  $30^{\circ}$  or  $32^{\circ}$  C. at the

toes Variations of several degrees in either direction may frequently be found In thrombo-angitis obliterans there is usually a general lowering of the temperature of the skin with a marked drop at the point where very poor circulation begins It is not a very reliable diagnostic sign, however, because the temperature is determined by the circulation in the skin and is independent of the deep circulation, and it may vary considerably in any one individual It is very useful in comparative studies to determine the effects of vasodilating agents

The oscillometer was first used in the study of peripheral vascular disturbances by Pachon<sup>15</sup> in 1909 It is an instrument which measures the maximal and minimal arterial pressures and the oscillations of the pressure in the arteries It consists essentially of a rubber bag armlet which is connected to a manometer and to an aneroid chamber which measures the rhythmic variations in the volume of that segment of the limb to which it is applied This is transmitted to a needle which oscillates over a graduated scale Its use has become widespread in the quantitative diagnosis of peripheral vascular disease and in the differentiation between organic and vascular disturbances Normally there is a gradual drop in the oscillometer readings taken from the thigh down to the foot or from the arm to the hand A sudden or too acute drop in the readings denotes vascular occlusion In a functional vascular occlusion the degree of oscillation will return to normal when the spasm is relieved by immersing the extremity in a hot bath for fifteen to thirty minutes The oscillometer cannot differentiate accurately between thrombo-angitis obliterans and other organic vascular occlusive conditions as arteriosclerosis According to Samuels<sup>16</sup> its value lies in (1) the detection of minute changes in the sum total of pulsations, (2) determination of changes in volume flow in regions in which the arteries are not accessible to the palpating fingers as in the region of the calf, (3) an accurate quantitative method for comparison of the condition of circulation during various phases of treatment or for comparison with other extremities, and (4) a valuable adjunct in the differential diagnosis of vasomotor and occlusive vascular disease

Cohen<sup>17</sup> in 1924 was the first to use the intracutaneous salt solution test in the diagnosis of peripheral vascular disturbances Normally it takes from thirty to sixty minutes for an intradermal wheal of physiological salt solution to become absorbed In cases of vascular occlusion the absorption of the salt solution and the disappearance of the wheal take place very rapidly due to the lowered fluid content of the tissues The height on the extremity and the degree of rapidity of the abnormally rapid absorption denote the height and the degree of vascular occlusion

Thomas Lewis<sup>18</sup> in 1927, following the original observations of Epinger<sup>19</sup> in 1913, demonstrated that the histamine reaction consisted of three distinct factors (1) A local dilatation of the capillaries, venules and arterioles by direct action, which caused a purplish spot to appear, (2) a widespread dilatation of the surrounding arterioles by local reflex action,

which was visible as a red flare, and (3) a local increase in the permeability of the walls of the minute vessels by direct action, which caused a wheal at the site of injection. He also demonstrated that if the circulation was completely cut off only a purple spot would form but no wheal or flare, and that coldness of the skin retarded the reaction. Starr<sup>20</sup> on that basis used this reaction in the study of peripheral vascular disturbances by the method of pricking the skin a number of times through a drop of histamine. He found that normally the skin reaction to histamine is at its height in two and one-half to five minutes and that the changes suggesting a reduction in circulation are (1) delay in appearance of the reaction, (2) delay in appearance plus a reduction in the intensity of the reaction, (3) failure of either flare or wheal to appear, (4) failure of both the flare and wheal to appear and the reaction to consist of only a purple spot which was a sign of complete obstruction.

The histamine test as now performed by de Takáts<sup>21</sup> consists of the intradermal injection of 0.1 cubic centimetres of 1:1000 histamine solution (ergamine acid phosphate). The reactions are the same as those described by Starr. The wheal is irregular but sharply defined and is usually  $\frac{1}{2}$  to 1 cubic centimetre in diameter. The flare surrounding it is also irregular but not raised and extends for 1 to 2 centimetres in each direction. The test is fairly accurate as a means of determination of circulatory efficiency and agrees closely with the oscillometric readings and the surface temperature as determined by the skin thermometer. Besides diminution in circulation, other factors which cause a delayed reaction are degeneration of cutaneous nerves, previous use of histamine at the same spot, injury of the skin by ultraviolet and X-rays or burns, and various skin diseases.

*Treatment*—In treating cases of thrombo-angitis obliterans, one must understand that the symptoms of which the patient complains are not due to the disease proper but to nature's method of healing the condition with its resultant vascular occlusion. One must also remember that there is a constant race between the obliteration of the vessels and the formation of a collateral circulation, and that the outcome is determined by the relative speed of the two processes. There is no proved specific treatment of thrombo-angitis obliterans. It is purely that of aiding the formation of a collateral circulation and in symptomatic relief. In general, the treatment can be divided into (1) the removal of factors which may predispose to recurrences, and (2) measures to increase the circulation and relieve the pain.

The use of tobacco on the part of the patient with thrombo-angitis obliterans is prohibited in most clinics. As has been stated before, although the exact relation that tobacco has to the disease is not known, it has been definitely established in numerous series of cases<sup>9, 10</sup> that patients who stop smoking improve much faster and more completely than those who do not.

Recently Kaunitz,<sup>22</sup> in a study of ergotism, found that there is a definite similarity in the symptoms and pathology between chronic endemic ergotism and thrombo-angitis obliterans. Russian and Polish Jews as a rule eat large

quantities of rye bread, which has been shown to contain considerable ergot. Whether ergot is a causative factor in thrombo-angitis obliterans and whether the effect of the ergot-containing rye bread upon the peripheral circulation is great enough to warrant elimination of that food from the diet is still a mooted question. Kaunitz advised prophylaxis and the elimination of as much ergot as possible from the foods.

Bed rest and heat to the extremity are among the simplest and most effective methods used to promote the formation of a collateral circulation. The period of rest should be from three to six weeks or more and should be accompanied by the application of dry heat for two hours several times daily. Diathermy and quartz-light treatment have their indication—the former to warm the extremity and by the relief of vascular spasm and vasodilatation to aid in the formation of a collateral circulation, and the latter to stimulate healing of superficial, slowly healing ulcers.

Buerger<sup>13</sup> devised a set of exercises which have been found to stimulate considerably the reestablishment of circulation. With the patient lying on his back the extremity is elevated  $60^{\circ}$  to  $90^{\circ}$  above horizontal for the minimum time required to produce ischæmia (thirty seconds to three minutes). It is then allowed to hang down until one minute after the appearance of the reactionary rubor (two minutes to five minutes). The extremity is then held in the horizontal position for three to five minutes, during which time dry heat in the form of a therapeutic lamp is applied. This cycle is repeated for one hour every alternating hour of the day.

Contrast foot baths aid greatly in the formation of a collateral circulation by means of the alternate contraction and dilatation of the vessels. The baths consist in alternately immersing the extremity for one-half to one minute in cold water at  $40^{\circ}$  to  $50^{\circ}$  F and warm water at  $100^{\circ}$  to  $110^{\circ}$  F. This should be continued for fifteen to thirty minutes several times daily and may follow the exercises described before.

Ever since the discovery by Mayesima in 1915 that in thrombo-angitis obliterans there is an increase in the blood viscosity, methods of treatment have been devised to combat this effect. The ingestion of large quantities of fluids, as Ringer's solution, Locke's solution, physiological salt solution and various concentrations of sodium citrate, has been tried. The solutions have been taken by mouth, by duodenal tube, by rectum, subcutaneously and intravenously with varying and on the whole poor results. Recently Silbert<sup>23</sup> at Mt Sinai Hospital in New York instituted the intravenous injection of 5 per cent sodium chloride solution in a large number of cases with apparently excellent results. He cites a series of 460 untreated cases in which 64 per cent required amputation within five years of the onset of the disease and 46 per cent required two amputations within ten years of the onset. In a group of 225 cases treated by the intravenous injection of 5 per cent sodium chloride solution amputation was required in only 83 per cent. There was symptomatic improvement in 84 per cent, and 67 per cent returned to work with complete relief from the symptoms. At the first

injection only 150 cubic centimetres of the solution are given to determine the sensitivity of the patient. Following this 300 cubic centimetres are given three times weekly for about a month and then gradually reduced. Improvement is usually noticed in several weeks. After the treatment has been stopped it may be necessary to repeat the courses at various intervals. Silbert believes that the improvement is due to a stretching of the vascular tree and to a dilution of the blood. This treatment is contraindicated in patients over sixty years of age and in those who show signs of an injured myocardium or poor renal function. It has been used with success in the treatment of gangrene in thrombo-angitis obliterans by Samuels,<sup>24</sup> who reports excellent results with relief of the pain and ultimate auto-amputation, and sometimes an intact extremity.

Foreign protein therapy in occlusive vascular conditions of the extremities was first described by Goodman and Gottesman<sup>25</sup> in 1923, who used this method for the relief of pain in cases of thrombo-angitis obliterans, after noting its effect in cases of chronic arthritis. Since then, numerous cases have been reported with excellent results in promoting the formation of a collateral circulation and relief of pain. The method of treatment consists in the intravenous injection of typhoid vaccine. Twenty-five million bacteria are given at the first injection and increased 15,000,000 to 25,000,000 at each succeeding dose. Doses of 500,000,000 bacteria have been given intravenously without deleterious effects. The injection of the vaccine is usually best given at intervals of four to five days but may be given daily if desired.

The reaction consists of three definite stages, a prodromal period, a stage of decrease in capillary flow and a stage of vasodilatation. The prodromal stage lasts from one-half to one hour and during this time the patient is perfectly comfortable. The second stage is usually initiated by a chill. The general body temperature rises, but there is a peripheral vasoconstriction and a drop in the skin temperature of the extremity. The patient may experience sharp pain in the involved extremities during this stage which may last from several minutes to an hour or more. Following this is the stage of vasodilatation. The general body temperature may continue to rise another degree or two, the extremities begin to feel warm, and the surface temperature may rise three to four degrees and sometimes as high as ten degrees above the starting temperature. This stage usually lasts six to ten hours.

This type of treatment is contraindicated in patients with heart or kidney disease, hypertension, and those in a debilitated condition. Occasionally it is possible to do harm if the stage of peripheral vasoconstriction is prolonged, especially in extremities on the verge of gangrene.

To eliminate some of the disagreeable effects of the chill and to shorten or eliminate the stage of vasoconstriction a typhoid "H" vaccine has been developed.<sup>26</sup> "It is a fraction of typhoid bacteria. After the organisms have been emulsified in sodium chloride solution they are killed with 0.5 per cent phenol, which for the most part blocks the other component, the 'O' antigen, and also acts as a preservative. The 'O' antigen is a non-specific

antigen which is a fraction of many different bacteria Typhoid 'H' antigen is thermo labile but keeps satisfactorily at room temperatures Its action is not inhibited by phenol or formaldehyde It is destroyed by alcohol It is apparently a specific antigen for typhoid bacteria" Barker<sup>26</sup> reports a series of cases comparing the effects of the ordinary typhoid vaccine (TAB) and typhoid "H" vaccine With the former, 75 per cent of the patients had a chill With the latter, only 27 per cent of the patients developed a chill The vasodilatory effects were similar

Waller and Allen<sup>27</sup> report the use of a 2 per cent sulphur suspension in oil injected intramuscularly to induce fever in cases of peripheral vascular disease, with varying results

Various operative procedures have been designed to increase the vascularity of the diseased extremities Artificial arteriovenous anastomosis was found to be feasible in normal experimental animals but has been unsuccessful in diseased human beings, first, because the vessels are thickened and contracted, and second, because the veins are also involved in the diseased process High ligation of the main arteries has been tried and successful cases reported<sup>28</sup> However, a clear understanding of the pathology in thrombo-angitis obliterans will demonstrate the obvious impossibility of improving the circulation by such a procedure Van Gorder<sup>29</sup> reports a series of nine cases in which he ligated the main vein with very excellent results He bases his method of treatment on the supposition that a restriction of the outflow of blood from the limb by ligation of the main vein will counterbalance the diminished blood supply due to the diseased artery Horton,<sup>30</sup> Holman,<sup>31</sup> Brooks,<sup>32</sup> and Pearse,<sup>33</sup> have demonstrated that ligation of the popliteal vein in cases of thrombo-angitis obliterans and arteriosclerotic gangrene results in an elevation of the temperature of the extremity This is apparently due to an increase in the residual arterial pressure, in the venous pressure, and in the peripheral arterial circulatory bed

The researches on the periarterial sympathetics by Rene Leriche in 1921<sup>34</sup> and a report on the successful treatment of various types of trophic disturbances, painful stumps, and causalgia by periarterial sympathectomy in 1924, stimulated the study of the relation of the sympathetic system to peripheral circulatory disturbances Many series of cases have been treated by the resection of the periarterial sympathetics but with very poor results A W Allen,<sup>35</sup> in a study of the end-results of such an operation in occlusive vascular disease of the extremities, states that "periarterial sympathectomy has a very limited field It is undoubtedly followed by a temporary hyperemia which is more effective than that produced by electrical or mechanical measures and will aid in the healing of ulceration It must be remembered, however, that the cases benefited by it will probably heal with a longer period of palliative treatment" An adequate explanation for the failure of periarterial sympathectomy in peripheral circulatory diseases is the demonstration by Potts<sup>36</sup> that the sympathetic nerve supply for the vessels of the lower extremities reaches the main vessels at intervals along their course from the neigh-

boring nerves Thus, stripping the femoral artery will not remove the sympathetic supply of its divisions lower down

Royle in 1924<sup>37</sup> in his studies on the relief of spastic disturbances of the lower extremities observed that there was an increase in the warmth of the extremity on the side operated upon Following this observation the operation of lumbar sympathetic ramisection and ganglionectomy was performed in Raynaud's disease and in occlusive vascular diseases of the extremity with excellent results<sup>38, 39, 40</sup> The basis for this operation in thrombo-angitis obliterans is the fact that in that condition there is both vascular occlusion and vascular spasm E V Allen<sup>39</sup> believes that impulses originating in the vessels are carried to the spinal cord and then are reflexly expressed as vasoconstriction Cutting the lumbar sympathetic chains breaks the reflex arc and allows vasodilatation It is not curative in occlusive vascular disease, but it allows the limb a maximum amount of blood This operative procedure is useful only in cases in which there is a definite vascular spasm This can be determined by the vasomotor index of Brown,<sup>41</sup> which is determined in the following manner Fever is induced with intravenous typhoid vaccine and the increase in surface temperature of the limb measured at one-half-hour intervals with a thermocouple galvanometer or skin thermometer The vasomotor index =  $\frac{\text{Rise in temperature minus rise in mouth temperature}}{\text{Rise in mouth temperature}}$  In

normal individuals the rise in surface temperature of the toes is greater than the rise in mouth temperature Unless indices of 15 or more are obtained, Brown does not advise an operation on the lumbar sympathetics Other methods for the selection of patients for this operation are the paravertebral block of the sympathetics with procaine<sup>42</sup> and the blocking of the peripheral nerves<sup>43</sup> In both methods there is a rise in the surface temperature if there is a vascular spasm accompanying the occlusion of the vessel In spite of the enthusiastic reports in the literature, however, Samuels<sup>24</sup> believes that the operation is too severe for the results obtained Leriche<sup>44</sup> believes that no sympathetic operation is of value in thrombo-angitis obliterans He believes that for the operation to do good there must be a partially intact peripheral circulatory system

Recently there have been reports<sup>45, 46</sup> of excellent results obtained in the treatment of Raynaud's disease and thrombo-angitis obliterans by irradiation of the lumbar sympathetic ganglia by the use of a very strong current

The relief of pain in thrombo-angitis obliterans goes along with the improvement in the general condition by the methods described above However, in the pregangrenous stage, when the pain is intolerable or when there is a large ulcer which causes extreme pain, other and more direct methods are necessary Silbert<sup>47</sup> and Smithwick and White<sup>48</sup> isolate the nerve supplying sensory fibres to the painful area and inject it with alcohol This causes a complete anaesthesia of that area for three to six months and has been found to aid greatly in cases having painful, slowly healing ulcers, allowing thorough Dakinization and removal of the necrotic tissue Because of the slow healing



of the operative wound due to the poor circulation, the nerves should be isolated above the ankle in all cases

Various other forms of therapy have been advised in thrombo-angitis obliterans Bæcke<sup>49</sup> in 1927 reported the successful outcome of a case after treatment with ovarian extract He bases his treatment upon the teachings of Marshak who believes that in thrombo-angitis obliterans there is a hypersecretion of the suprarenal glands and that this is neutralized by ovarian extracts He offers as proof of this hypothesis, the almost complete absence of the disease in females Based on similar conclusions other European surgeons advocated suprarenalectomy<sup>50</sup> However, Herzberg<sup>51</sup> in a survey of 120 cases treated by suprarenalectomy states that although the immediate results are good the majority of the cases finally required amputation Schwartzman<sup>52</sup> reported good results in forty-two cases treated by the daily injection of muscle extract on the basis that the extract acts as a powerful depressor and overcomes vascular spasm

Gangrene of the extremity is the much-dreaded final stage in thrombo-angitis obliterans Its treatment is usually amputation, although ultra-conservatism is advocated even in that stage by most authors However, if amputation has to be resorted to finally, it should always be done above the point of deficient circulation, which should be determined by the use of the oscillometer and by the rise in surface temperature after typhoid injections

In summarizing the recent advances in thrombo-angitis obliterans, we see that its diagnosis does not mean that the patient is doomed to go through life on artificial legs, that the prognosis is not utterly hopeless and that the keynote of present-day treatment is conservatism

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# THROMBO-ANGIITIS OBLITERANS

## RELIEF OF PAIN BY PERIPHERAL NERVE SECTION

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PAIN is an early and important symptom in thrombo-angitis obliterans. It may be due to the migrating phlebitis which occurs in the early stage of the disease. Local infection of the foot with tenosynovitis or abscess formation occasionally produces severe pain. More frequently, however, pain is the result of anoxemia of the distal tissues induced by arterial thrombosis. Lesions secondary to this, such as fissures, ulcerations or gangrene, may be responsible for the most violent forms of pain observed in this disease.

Relief of pain in thrombo-angitis obliterans is of primary importance, and the success of conservative treatment depends upon it. Continuous severe pain often results in destroying the patient's morale by interfering with his sleep. Even the generous use of narcotics is insufficient to give relief in some instances.

The tendency in the treatment of this disease has been towards conservatism, and the results in the past few years have justified this attitude. Patients with ulcers or local gangrene formerly came to early amputation, in many cases due to the fact that severe pain could not be relieved. On account of the extreme sensitiveness of the ulcerated areas it was practically impossible, in the average patient, to dress or Dakinize these wounds satisfactorily. Attempts to relieve pain by the use of anæsthetic ointments are harmful in our opinion, inasmuch as these medicaments destroy tissue and tend to increase ulceration.

In 1922, one of us,<sup>1</sup> was the first to report a series of four cases in which the posterior tibial nerve was blocked with alcohol for the relief of pain in thrombo-angitis obliterans. All four patients had complete relief, though in one case the foot became gangrenous and in another the wound healed slowly. In 1929, Corlette<sup>2</sup> reported a method of cutting the terminal sensory nerves by a subcutaneous transverse incision above the painful ulcers of the malleolus. Smithwick and White,<sup>3</sup> in 1930, reported eleven cases in which the sensory nerves of the leg were injected with alcohol. Relief of pain was accomplished in all. In November, 1932, Allen<sup>4</sup> summarized the results from the same clinic, reporting a total of twenty-nine cases.

Recently we have decided that simple section of the nerve with immediate suture is superior to alcohol injection. The objections to the latter method are twofold. (1) It is impossible to be assured in employing alcohol injections that some of the nerve fibres may not be missed and result in persistence of some of the pain. (2) There is also the possible danger of producing ulcers from the inadvertent spilling or seeping of alcohol into tissues.

In carrying out the technic of nerve section the anatomical distribution of the nerves supplying the foot as well as their function must be clearly borne in mind. There are only five nerves which supply sensation to the

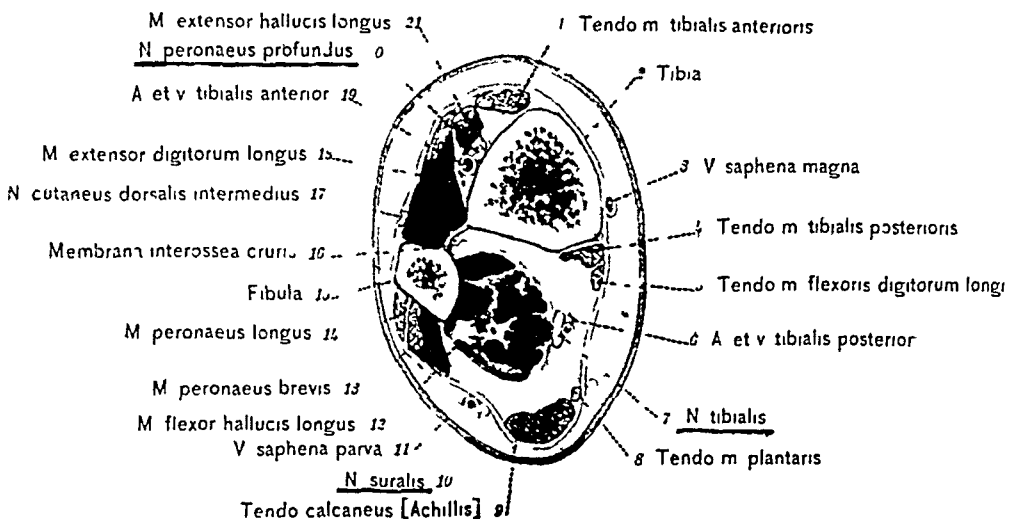


FIG 1—Cross section of leg (3 1/2 inches above internal malleolus) showing the position and relation of nerves in the lower extremity (From Eycleshymer and Schoemaker A Cross Section Anatomy, D Appleton & Co)

foot. These are the posterior tibial, deep peroneal (anterior tibial), superficial peroneal (musculocutaneous), sural (external saphenous), and the internal saphenous.

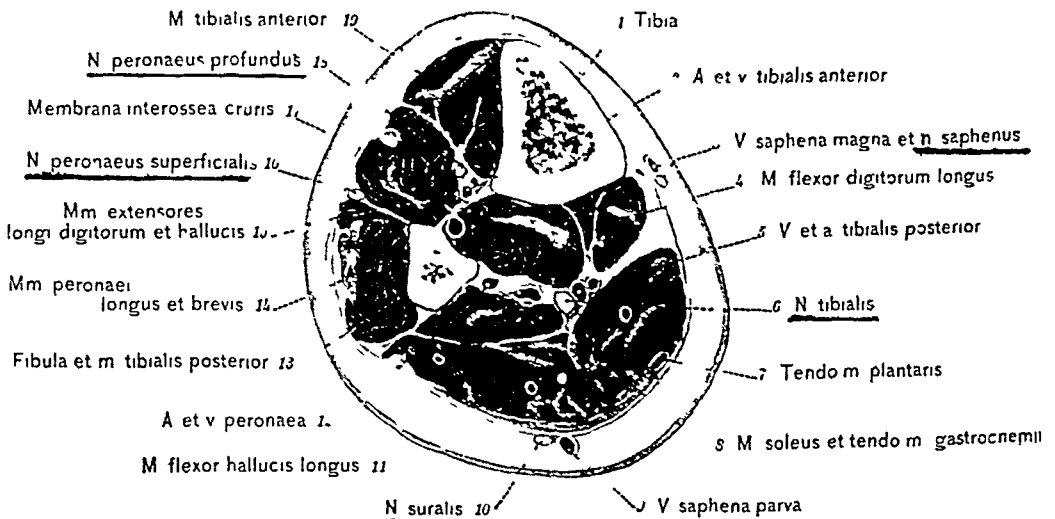


FIG 2—Cross section of leg (5 inches above the internal malleolus) showing the position and relation of nerves in the lower extremity (From Eycleshymer and Schoemaker A Cross Section Anatomy, D Appleton & Co)

The posterior tibial nerve (Figs 1, 2 and 3) is one of the terminal divisions of the sciatic nerve. It carries motor fibres to the muscles of the calf and the intrinsic muscles of the foot. Its sensory distribution is to the entire sole of the foot and the dorsum of the tips of the distal phalanges of all the toes. The course of the nerve is from the middle of the popliteal space downward and inward to the inside of the ankle. In

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the lower third of the leg it lies lateral to the posterior tibial blood vessels, becoming more posterior as the structures approach the ankle. The tendons of the flexor longus digitorum and posterior tibial muscles are anterior and the flexor hallucis longus is posterior to the neurovascular bundle. The nerve gives off a branch just above the ankle, the plantar interosseous (medial calcaneal) nerve, which perforates the internal annular ligament and supplies sensation to the heel and adjoining part of the sole of the foot and lower down divides into two branches (a) the internal (medial) and (b) the external (lateral) plantar nerves which are distributed to the rest of the sole and intrinsic foot muscles.

The deep peroneal (anterior tibial) nerve (Figs 1, 2, 4 and 6) is a continuation of the common peroneal (external popliteal) nerve. It is a mixed nerve carrying motor fibres for the anterior leg muscles and intrinsic muscles of the foot. It supplies sensation to the tarsal bones and the joints of the foot. Its distribution in the skin is to the contiguous sides of the great (first) and second toes, and a small area between the heads of the first and second metatarsals. The nerve descends lateral to the tibia

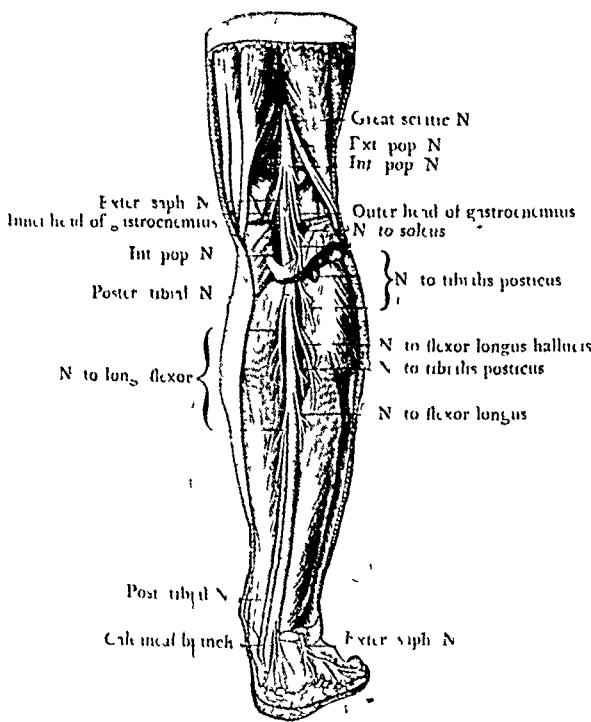


FIG 3

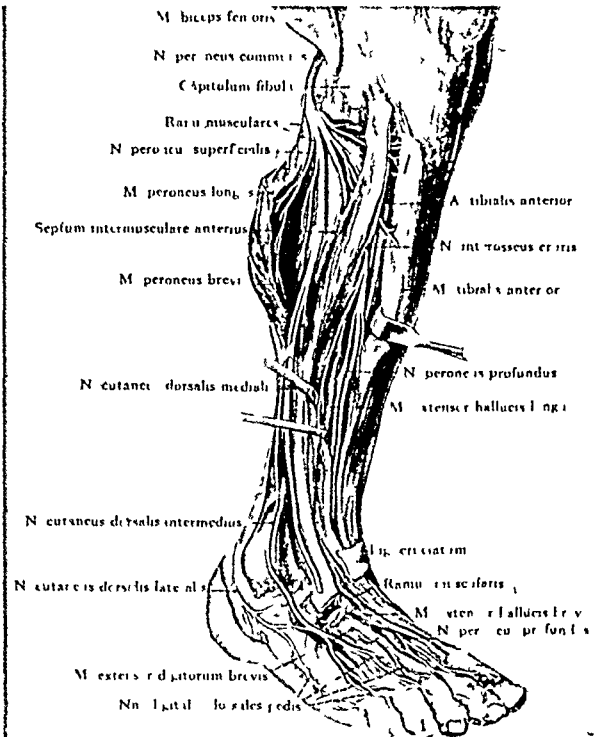


FIG 4

FIG 3—Course of posterior tibial nerve showing calcaneal branch (After Sappey) (From Tinel, Nerve Wounds, William Wood and Company)

FIG 4—Course of superficial and deep peroneal nerves showing the bifurcation of the former (From Pollock and Davis, Peripheral Nerve Injuries, Paul B Hoeber, Inc)

and anterior to the interosseous membrane. In the lower third of the leg the nerve generally lies in front of the anterior tibial vessels. At its upper level the nerve lies between the anterior tibial and extensor digitorum longus muscles. Just above the ankle it lies between the extensor hallucis longus and the extensor digitorum longus.

The superficial peroneal (musculocutaneous) nerve (Figs 1, 2, 4 and 6) also arises from the common peroneal. It gives off muscular branches in the upper third of the leg and is entirely sensory below this point. At the junction of the middle and lower thirds of the leg (about six inches above the ankle) it pierces the deep fascia and lower down divides into medial and lateral branches. It supplies sensation to the entire dorsum of the ankle and foot with the exception of the area between the base of the great and second toes (deep peroneal), lateral side of the foot and little toe (sural) and tips of toes (posterior tibial). The distribution of the terminal branches of this nerve varies and often the extreme lateral branch is replaced by the sural nerve.

The sural (external or short saphenous) nerve (Figs 1, 2 and 5) is formed by the union of the lateral sural cutaneous nerve (branch of the common peroneal) either directly or through a connecting branch, the peroneal anastomotic, with the medial sural cutaneous nerve (branch of the sciatic). The junction of these two nerves may take place at any point between the popliteal space and the lower third of the leg. The nerve descends along the lateral border of the tendo achillis, passes posterior to the lateral malleolus and turning forward it continues along the lateral side of the foot and divides into two branches. It supplies sensation to the skin of the lower lateral

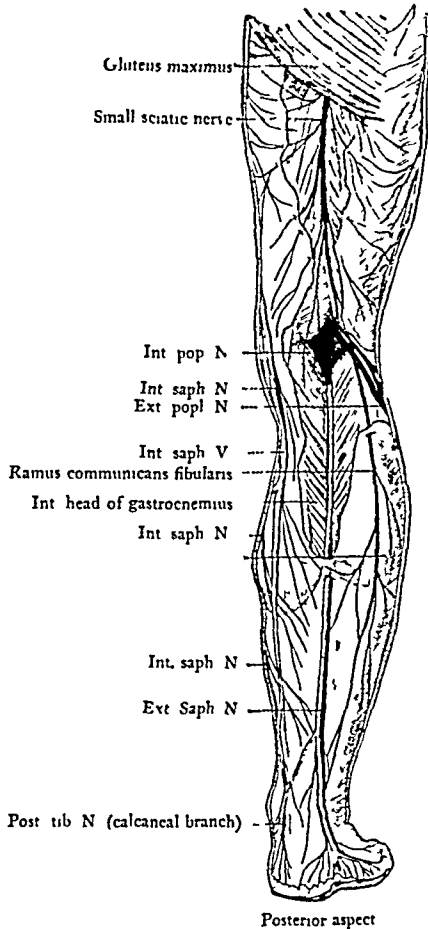


FIG 5

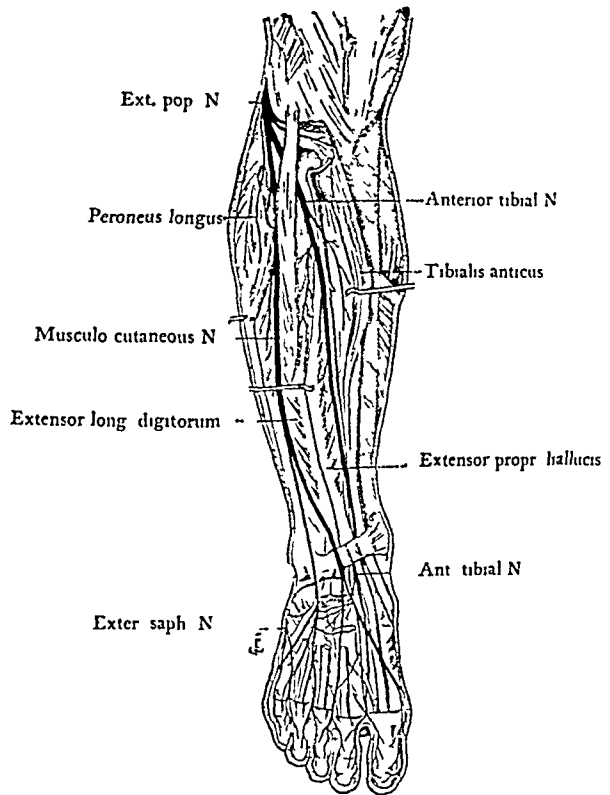


FIG 6

FIG 5—Course of the sural (external saphenous) nerve lying adjacent to the external saphenous vein (After Hirschfeld) (From Tinel, Nerve Wounds, William Wood and Company)  
FIG 6—Course and distribution of the superficial and deep peroneal nerves (After Hirschfeld) (From Tinel, Nerve Wounds, William Wood and Company)

part of the leg, lateral side of the heel and lateral side of the foot and dorsal and lateral surfaces of the fifth toe, often including the lateral side of the fourth toe

The saphenous nerve (Figs 1 and 2), one of the terminal branches of the femoral nerve, descends with the great saphenous vein along the inner border of the upper two-thirds of the tibia and then crosses the medial surface of the lower third of the tibia, passes in front of the internal malleolus to the ball of the great toe. This nerve supplies sensation to the integument of the medial side of the leg and foot

*Surgical Technic*—The posterior tibial nerve is exposed by a three-inch vertical incision one to four inches above the internal malleolus and about one inch behind the posterior border of the tibia or parallel to the inner margin of the tendo achillis. The deep fascia is opened and the neurovascular bundle is isolated by blunt separation of the fascial planes between the flexor digitorum longus and the gastrocnemius and

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soleus muscles (Fig 2) The nerve lies about three-quarters to one inch beneath the skin surface and immediately beneath or lateral to the artery and vein. It is about three-eighths of an inch in diameter and can be mistaken for a tendon by an inexperienced operator. The operative incision may be made at a somewhat lower level, in which case the nerve lies directly under the deep fascia, posterior and slightly lateral to the artery and vein, with the tendon of the flexor hallucis longus lying posterior and the tendons of the flexor digitorum longus and posterior tibial lying anterior. If the nerve is sectioned at the malleolus or not more than one inch above it, the posterior half of the sole is not anaesthetized inasmuch as the plantar interosseous (medial calcaneal) nerve comes off proximal to this point (Fig 3). After exposure, the nerve is separated from the artery and vein with great care so as to damage the vascular structures as little as possible. One or two fine silk sutures are passed vertically through the nerve and the structure is then divided by a transverse incision. On tying the sutures the cut ends of the nerve are accurately approximated without rotation. A small blood-vessel is usually present in the posterior tibial nerve which must be ligated after section. After careful hemostasis, the skin wound is closed with a few interrupted silk sutures.

The deep peroneal (anterior tibial) nerve is exposed by a three-inch vertical incision about two to four inches above the ankle. The incision is made just lateral to the tendon of the extensor hallucis longus which can readily be palpated and should be placed about one-half inch lateral to the crest of the tibia. The deep fascia is incised and the neurovascular bundle exposed by blunt dissection between the extensor hallucis longus and the extensor digitorum longus muscles (Fig 1). This bundle lies at a depth of about one and one-quarter inches in the average case. The nerve is the most anterior structure here and is about one-eighth inch in diameter. It is dealt with in exactly the same manner as has been described for the posterior tibial.

The superficial peroneal (musculocutaneous) nerve is exposed by a three-inch linear incision about five to six inches above the external malleolus, parallel to the border of the fibula and about one inch anterior to it. The nerve is usually found just beneath the deep fascia, though it is often just above it. It is ovoid in shape and about one-quarter inch in diameter and is not associated with any large vessels. It lies between the long and short peronei muscles on the lateral side and the extensor digitorum longus muscles on the medial side (Fig 2).

The sural nerve is exposed by a vertical incision about five inches above the internal malleolus, just lateral to the mid-line. It lies above the deep fascia and close to the external saphenous vein and is about one-eighth inch in diameter (Fig 2).

The saphenous nerve is exposed by a vertical incision five inches above the ankle in the middle of the medial surface of the leg. Its location is above the deep fascia usually posterior to the internal saphenous vein. It is about one-sixteenth to one-eighth inch in diameter (Fig 2).

The operation may be done under local or spinal anaesthesia. The former method has the advantage that it is possible to test the completeness of the procedure immediately by the area of anaesthesia produced. When local anaesthetics are used the exposed nerve must be anaesthetized with novocaine before it is divided.

The most common site of ulceration in patients with thrombo-angitis obliterans is the dorsal surface of the great toe. In order to produce anaesthesia of this toe it is necessary to divide the posterior tibial, superficial and deep peroneal nerves. Anaesthetization of the fourth toe usually necessitates the sectioning of the posterior tibial, superficial and deep peroneal and sural nerves. The deep peroneal nerve supplies deep sensation to the foot, *i e*, to the tarsal bones and joints, and unless this nerve is sectioned the



patient may continue to complain of pain, even though the skin in the ulcerated area is anæsthetic. Frequently an ulcer will enlarge so as to involve an unanæsthetized area and then another nerve must be divided. From a

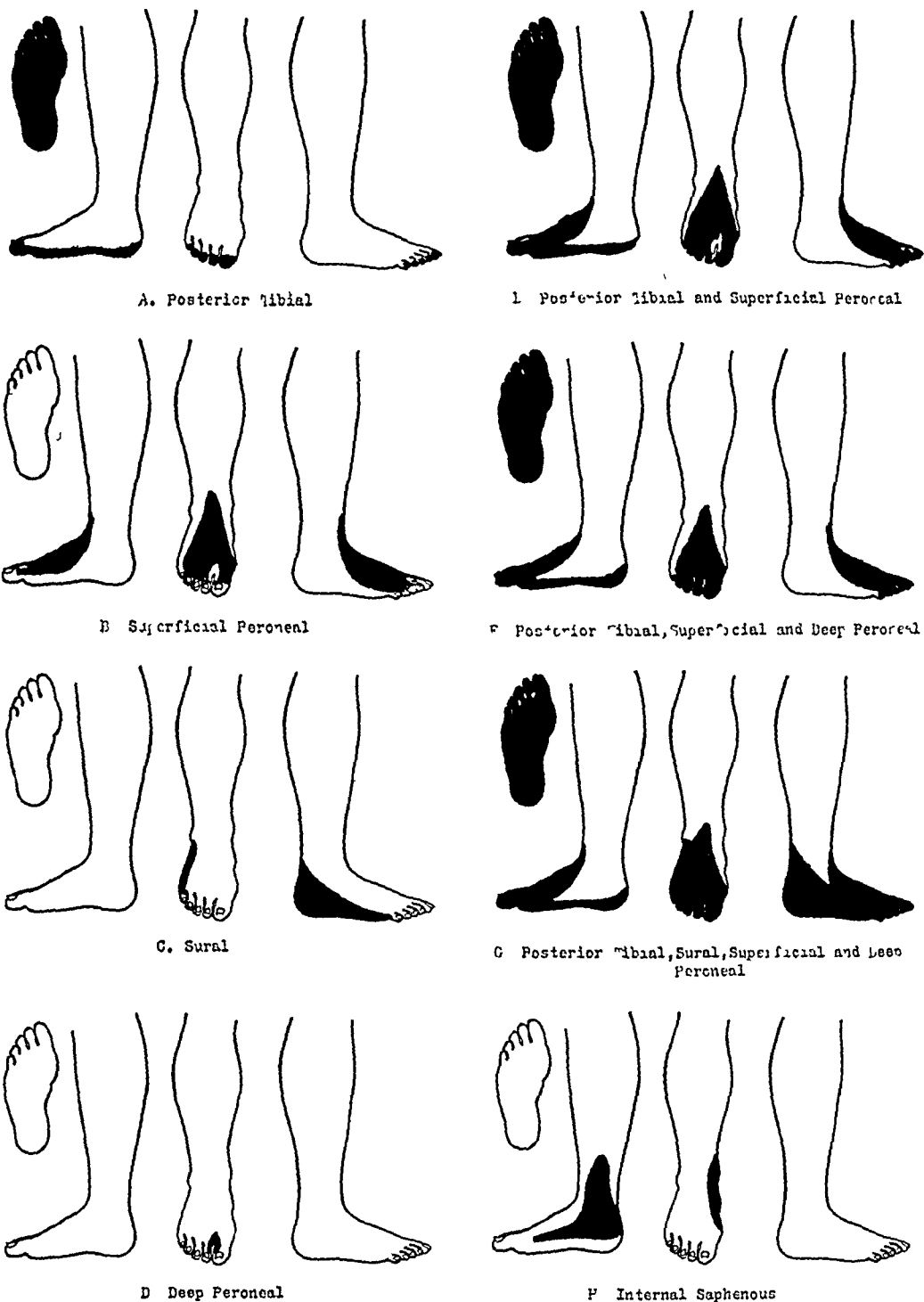


FIG 7—Areas of anesthesia produced by section of one or more nerves

study of Fig 7 it is simple to decide what nerve or combination of nerves must be sectioned in order to produce anesthesia of the desired area. We have noted that nerve determinations usually overlap in their sensory distri-

bution and it is often necessary to produce a wide area of anæsthesia to desensitize marginal painful lesions

It must be recognized that incisions to expose these nerves are made into relatively devitalized tissues. More than ordinary care to avoid trauma, and rigid asepsis to prevent even slight infection are essential if satisfactory healing of wounds is to take place. In our experience healing by primary union has been the rule, although in an occasional instance some difficulty has been experienced.

Since the nerve sections are carried out in the lower third of the leg, the innervation of all the leg muscles is left intact and no difficulty in walking results from the operation. Paralysis of the small intrinsic muscles of the foot is produced, but is of no importance, because these muscles are not employed in standing or walking. The loss of sensation requires that the patient use care to avoid injuring the foot. The wearing of shoes is usually sufficient to prevent such an accident. The anæsthesia induced is temporary, and a fairly satisfactory return of sensation may be anticipated in the course of time.

Occasionally section of one of the peripheral nerves is followed by incomplete anæsthesia in the area usually supplied by this nerve. This is due to some abnormality or unusual branching of the nerve. The course of the abnormal branch can be readily established by laying down a series of subcutaneous injections of novocaine. After each injection the area to be anæsthetized is tested. When the area suddenly loses its sensitivity, the aberrant nerve in question is exactly located by the last injection of novocaine. Exposure of the nerve by a small incision at this point and section as described results in satisfactory anæsthesia.

The method described above has been carried out in eighteen cases selected from patients under treatment in the Thrombo-Angitis Obliterans Clinic in the Out-Patient Department of the Mount Sinai Hospital and from the authors' private practices. All of the patients operated upon had ulcerative or gangrenous lesions of the foot. All had been suffering severely for some time previous to the operation. These patients had been receiving the routine treatment of intravenous injections of hypertonic saline solution as well as surgical care of the local lesions. The value of nerve section as an additional measure in those patients suffering with severe pain is strikingly illustrated in the following cases.

CASE I—N. R., male, aged forty-one. Russian-Hebrew, barber by trade, had a typical history of thrombo-angitis obliterans with intermittent claudication for past fourteen years. Within this period he had lost one toe. He smoked twelve cigarettes daily. In August, 1931, he had developed an ulcer one and one-half to one-half inch on the stump of the left second toe and adjoining surface of big toe. He complained of severe pain and was unable to sleep. No pulse could be felt in the foot and the oscillometer reading at the ankle was one and one-quarter. Under local anæsthesia the posterior tibial, superficial and deep peroneal nerves were sectioned. Relief of pain was immediate and the patient slept thereafter without medication. The operative incisions healed by primary union. The ulcers were dressed daily and Dakinized. By

September, 1931, the ulcers were entirely healed. In April, 1932, he injured the bottom of the left big toe by means of a nail and a round ulcer about one-quarter inch in diameter appeared. This healed slowly on strapping with adhesive. Examination in October, 1932, revealed that about 90 per cent of the sensation had returned in his foot.

CASE II—B L, male, aged thirty-seven, Russian-Hebrew, tobacconist by occupation. He had suffered with thrombo-angitis obliterans and intermittent claudication for three years. In 1928 he had lost one toe. His tobacco consumption was forty cigarettes daily. In November, 1931, he presented himself with an ulcer one-half to three-quarters of an inch in diameter on the dorsum of the left second toe directly over the phalangeal joint. No pulse could be felt in the left foot. The oscillometer reading at the ankle was 0.4. Pain was the cardinal symptom. An anæsthetic ointment had been used previously and the ulcer had become larger. Under spinal anæsthesia the posterior tibial, superficial and deep peroneal nerves were sectioned and the left second toe amputated. Complete relief of pain was accomplished immediately. The operative incisions healed by primary union. Healing of the ulcer was delayed by the presence of a small sequestrum, but at the end of five months complete healing had occurred. In September, 1932, sensation had returned to the entire foot except the tip of the big toe. There has been no recurrence of ulceration.

CASE III—H D, male, aged thirty-nine, Polish-Hebrew, writer by occupation. He had a typical history of thrombo-angitis obliterans for the past eight years. In 1923 he had lost his left leg. He smoked twenty-five cigarettes daily. In February, 1932, ulcers were present on the right fourth and fifth toes, and the third toe was gangrenous. He complained of severe pain and was taking large doses of morphine without relief. The oscillometer reading at the ankle was 0.5. No pulse could be felt in the foot. Under spinal anæsthesia the posterior tibial, superficial and deep peroneals and sural nerves were sectioned. Complete relief of pain was obtained and the patient was at once made comfortable. Later the fourth and fifth toes became gangrenous and were removed with the third toe. The operative incisions healed by primary union. He was dressed daily and Dakinized and by May, 1932, the ulcers had entirely healed and have not recurred. Sensation is returning.

CASE IV—L B, male, aged thirty-nine, Austrian-Hebrew, clerk by occupation. He gave a typical history of thrombo-angitis obliterans for two years. In February, 1932, an ulcer developed on the right second and third toes. He had severe pain and had been unable to sleep for the past three weeks. He smoked twenty cigarettes daily. On April 4, 1932, an examination revealed deep ulcers one-half to one inch on the dorsum of the right second and third toes. No pulse could be felt in the right foot. The oscillometer reading at the ankle was 1.0. Under local anæsthesia the posterior tibial, superficial and deep peroneal nerves were sectioned. Complete anæsthesia and relief of pain were obtained and the patient was able to sleep without medication. A few days later the second and third toes became gangrenous and were removed. Subsequently the fourth toe became gangrenous and patient complained of pain in the fifth toe. The sural nerve was therefore divided under local anæsthesia and complete relief of pain followed. Later the fourth toe was removed. The operative incisions healed by primary union. Dakinization and daily dressings with a bland ointment were instituted. By July, 1932, the foot had entirely healed. Sensation in the foot has begun to return.

CASE V—S M, male, aged forty-eight, Russian-Hebrew, tailor by trade. He gave a history of intermittent claudication for six months with migrating phlebitis a few years previous. He smoked twenty cigarettes daily. In October, 1931, a small ulcer appeared on the left big toe and by May, 1932, it had progressed so that the entire toe was gangrenous. He had severe pain and had not slept for many weeks, even with narcotics. No pulse could be felt in the left foot. The oscillometer reading at the ankle was zero (0). Under spinal anæsthesia the posterior tibial, superficial

and deep peroneal nerves were sectioned. Complete relief of pain was obtained. The operative incisions healed by primary union. Later the gangrenous left big toe was removed (Fig 8). An infection at the base of the amputated toe developed and was incised and drained. With Dakinization and daily dressings the wound had entirely healed by October, 1932. The patient is now walking and is free from pain. Sensation has already returned to a considerable degree.

CASE VI—A G, male, aged forty-two, Russian-Hebrew, clothes cutter by occupation. He had a typical case of thrombo-angiitis obliterans for eight years with intermittent claudication in both legs after walking one-half block. He smoked fifteen cigarettes daily. In March, 1932, the right big toe became gangrenous. Both popliteal arteries were closed and there was no pulse in either foot. The oscillometer reading at both ankles was zero (0). He had severe pain. We recognized this as a particularly unfavorable case because of the very advanced impairment of circulation, but decided to try nerve section combined with femoral vein ligation as a last resort before proceeding to amputation. Under local anæsthesia the posterior tibial, superficial and deep peroneal nerves were sectioned. Complete anæsthesia and relief of pain was obtained. The patient continued to smoke. The gangrene progressed and the operative incisions did not heal, so that a high amputation was necessary.

CASE VII—S L, male, aged twenty-seven, Russian-Hebrew, glazier by trade. He was a typical case of thrombo-angiitis obliterans with an eight months' history of intermittent claudication after walking one and one-half blocks. He smoked fifteen cigarettes daily. In June, 1932, an ulcer three-quarters of an inch in diameter was present on the plantar surface of the left fourth toe, extending onto the sole. There was a small anterior tibial pulse in the left foot. The oscillometer reading at the ankle was 0.5. He complained of severe pain. Under local anæsthesia the posterior tibial and sural nerves were sectioned. Relief of pain was accomplished. Later the ulcer extended into the region supplied by the superficial peroneal nerve and this also was sectioned. Pain was then entirely relieved. The operative incisions healed by primary union. About a week after nerve section the patient complained of transitory shooting pains in the entire foot, which disappeared after ten days. With daily dressings and Dakinization the ulcer healed slowly.

CASE VIII—J B, male, aged thirty-two, Russian-Hebrew, painter by trade. He was a typical case of thrombo-angiitis obliterans with intermittent claudication for the past five years. He smoked eighteen cigarettes daily. In January, 1932, an infection commenced under the left big toe and spread rapidly so as to involve the entire digit. He complained of severe pain. There was no pulse in either foot and both popliteals were closed. The oscillometer reading at both ankles was zero (0). Under local anæsthesia the posterior tibial, superficial and deep peroneal nerves were sectioned. Complete relief of pain was obtained. The operative incisions healed by primary union. Gangrene progressed rapidly and involved almost the entire foot, but pain did not recur. The patient showed evidence of considerable toxic absorption, and since a useful foot could no longer be saved, an amputation five inches below the knee was done. The stump healed by primary union in about three weeks.

CASE IX—F F, male, aged forty-three, Puerto Rican, wireman by occupation. He had complained of intermittent claudication and cold feet for a few years. He smoked twenty cigarettes daily. No pulse could be felt in either foot and the oscillometer reading at the ankles was very faint. In July, 1932, an ulcer appeared on the right big toe and rapidly became larger so that the entire toe was soon gangrenous. There was also an ulcer at the base of the right fifth toe. The pain was severe. Under local anæsthesia the posterior tibial, superficial and deep peroneals and sural nerves were sectioned. This produced anæsthesia of the entire foot except the fourth toe and an area one inch in diameter at the base of this toe. The fourth toe became entirely gangrenous and local pain recurred. The anterior branch of the sural nerve had

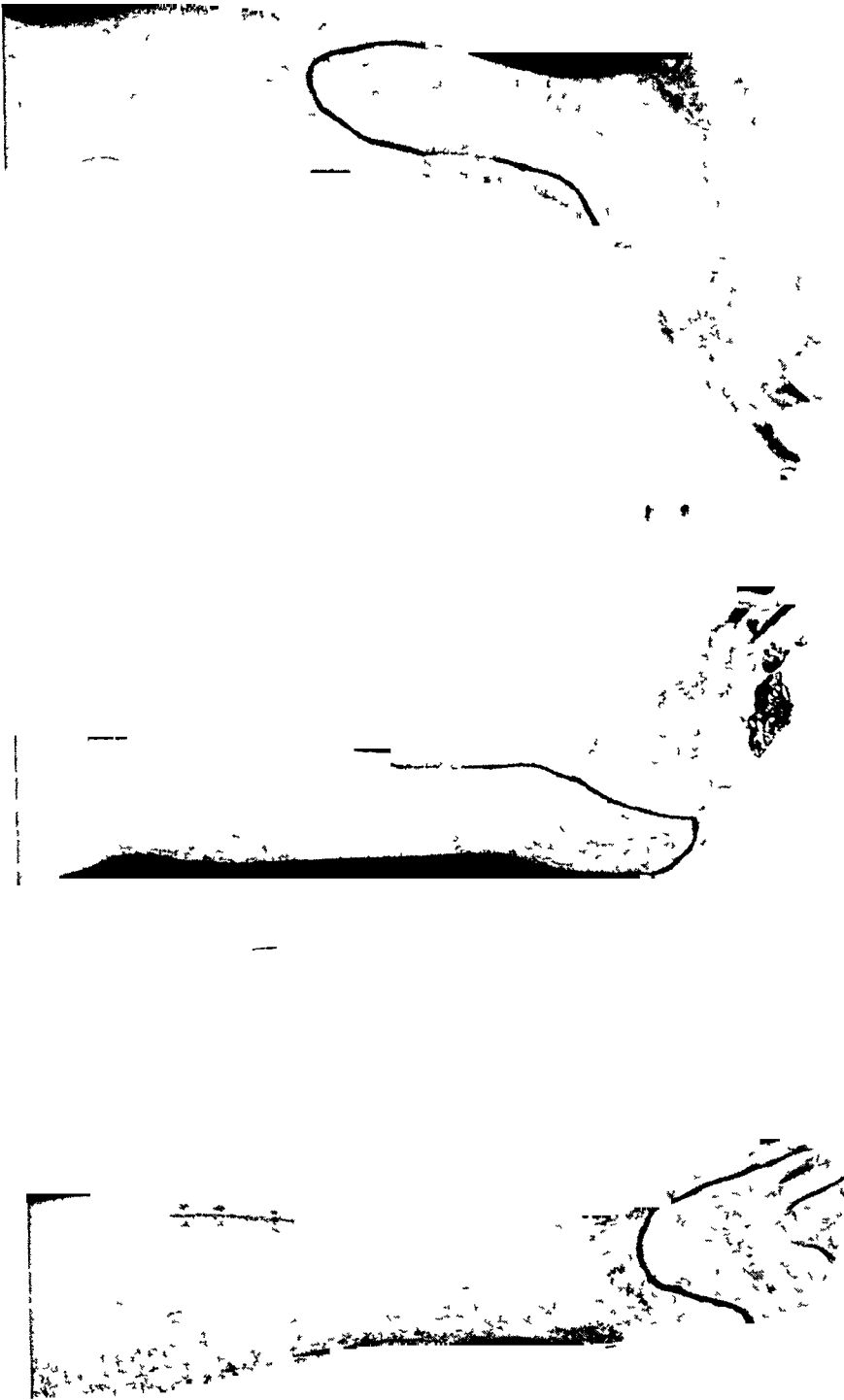


FIG 8

FIG 8 —(Case V) Photograph showing foot entirely healed after removal of gangrenous big toe. Area of anesthesia indicated. Note healed scars of nerve sections in lower leg (November 1932).  
 FIG 9a —(Case IX) Photograph showing ulcers on foot after removal of gangrenous big and fourth toes. Area of anesthesia indicated. Note healed operative incisions in lower leg. Four months after operation (November, 1932).  
 FIG 9b —(Case IX) Photograph showing ulcers on foot after removal of gangrenous big and fourth toes. Area of anesthesia indicated. Note healed operative incisions in lower leg. Four months after operation (November 1932).

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escaped section at the previous operation. Its course was located by novocaine injections as lying directly below the external malleolus and it was then divided. Complete relief of pain was promptly obtained. The operative incisions healed by primary union. The foot was Dakinized and bland ointment dressings applied. The right big toe and fourth toe were removed (Fig 9) and the foot is entirely healed at present.

CASE X—E K, male, aged thirty-four, Russian-Hebrew, truckman by occupation, had a typical case of thrombo-angitis obliterans for five years with intermittent claudication. He was able to walk only one-half block. He smoked twenty cigarettes daily. No pulse could be felt in either foot. The oscillometer reading at both ankles was very faint. In August, 1931, an ulcer developed on the lateral side of the right second toe and progressed to involve the right big toe. Both toes became gangrenous and the patient suffered severely on account of pain. Under spinal anaesthesia the posterior tibial, superficial and deep peroneal nerves were sectioned. Complete relief of pain was obtained immediately. The operative incisions healed by primary union. The gangrene progressed rapidly and the patient showed signs of a spreading infection with temperature of  $104^{\circ}$ . An immediate thigh amputation was therefore necessary. Following this, the patient made an uneventful recovery.

CASE XI—B F, male, aged forty-two, Russian-Hebrew, clothes cutter by occupation, gave a typical history of thrombo-angitis obliterans. He smoked fifteen cigarettes daily. In January, 1932, he had a painful ulcer, one inch by one-half inch, over the left internal malleolus. No pulse could be felt in either foot and the oscillometer reading at the ankles was 0.3. In January, 1932, under local anaesthesia, the internal saphenous nerve was sectioned and anaesthesia produced with complete relief of pain. The ulcer and operative incision healed slowly. By December, 1932, sensation had entirely returned.

CASE XII—C F, male, aged forty-eight, Scotch-American, clerk by occupation. He had a history of intermittent claudication in the left leg for eight years and in the right leg for three months. He smoked heavily. Seven years ago he had lost three toes of the left foot (Fig 10). He also had recurrent ulcers of both hands. Examination revealed gangrene of the right first, second, third and fourth toes extending over onto the dorsal and plantar surfaces of the foot. The oscillometer reading at the ankles was very faint. He had severe pain. In July, 1932, under spinal anaesthesia the posterior tibial, superficial and deep peroneals and sural nerves were sectioned. Complete relief of pain was accomplished. The operative incisions healed by primary union. The gangrenous toes and protruding bones were subsequently removed. The foot is almost entirely healed.

CASE XIII—D N, male, aged forty-five, Russian-Hebrew, window cleaner by occupation. He gave a history of intermittent claudication in the right leg for one year and an ulcer on the right big toe for five months. He smoked fifty cigarettes daily. He had considerable pain. Examination revealed an ulcer one by two centimetres on the right big toe extending under the nail. The femoral pulse was open, but the popliteal was closed. There was no pulsation at the ankle. The oscillometer reading at the ankle was very faint. In May, 1932, under local anaesthesia, the posterior tibial, superficial and deep peroneal nerves were sectioned. Complete relief of pain was obtained. The operative incisions healed by primary union. The distal half of the big toe was later amputated. Subsequently an infection developed on the sole and dorsum of the foot and was drained. There was progression of the infection involving the ankle-joint, so an amputation five inches below the knee was required. The stump healed rapidly.

CASE XIV—A L, male, aged forty-six, Russian-Hebrew, gave a typical history of thrombo-angitis obliterans. For one month he had an ulcer on the right fourth toe with severe pain. He smoked ten cigars daily. Examination revealed an ulcer on the posterior and lateral surfaces of the right fourth toe. There was no pulse in the foot and the oscillometer reading at the ankle was zero (0). In September, 1932, under local

anæsthesia, the posterior tibial, superficial peroneal and sural nerves were sectioned. This produced complete anæsthesia of the fourth toe, but some pain persisted. This was subsequently relieved by section of the deep peroneal nerve. The operative incisions healed by primary union. The fourth toe became completely gangrenous and was removed. The ulcer is healing rapidly.

CASE XV—M F, male, aged twenty-five, Russian-Hebrew, carpenter by trade. He gave a typical history of thrombo-angitis obliterans for two years with marked involvement of the right upper extremity. For the past four months he had an ulcer on the right big toe one and one-half inches in diameter involving the interphalangeal joint. He complained of severe pain. He smoked fifteen cigarettes daily. There was no pulse in the right foot. The oscillometer reading at the ankle was 25. In November, 1931, under local anæsthesia, the posterior tibial, superficial and deep peroneal nerves were sectioned. Complete relief of pain was obtained. The operative incisions healed by primary union. The distal portion of the big toe was amputated and the ulcer healed in a few months.

CASE XVI—I F, male, aged forty-seven, American-Hebrew, newsdealer by occupation. He gave a typical history of thrombo-angitis obliterans with the loss of the left leg three years previously. He smoked thirty cigarettes daily. The present condition commenced a few months ago with ulcers on the right second, third, fourth and fifth toes. This progressed to gangrene and spontaneous amputation. He then presented a large ulcer at the base of the toes and on the dorsum and sole of the foot. He had severe pain. The femoral pulse was the only one in the right lower extremity. The oscillometer reading at the ankle was very faint. In June, 1931, under local anæsthesia, the posterior tibial, superficial and deep peroneal nerves were sectioned. Almost complete relief of pain was obtained (Fig 11). This was due to the fact that the sural nerve was not divided, leaving some sensation in the fifth toe. The operative incisions healed in four months and sensation has returned to the entire foot as far as the big toe. There has been no recurrence of pain or ulceration.

CASE XVII—S R, male, aged sixty years, Russian-Hebrew, theatre manager by occupation, was a border-line case of thrombo-angitis obliterans with a history of intermittent claudication for six years. He smoked twenty cigarettes daily. For the past two months he had severe pain and impending gangrene of the right foot. There was no pulse at the right ankle and the oscillometer reading at the ankle was very faint. In February, 1932, under local anæsthesia, the posterior tibial, superficial and deep peroneal nerves were sectioned. There was complete relief of pain. The first and second toes became gangrenous, demarcated and amputated spontaneously. The operative incisions healed by primary union. The ulcers at the base of the toes are healing rapidly. There has been a partial return of sensation.

CASE XVIII—F A, male, aged twenty-two, Italian, clothes cutter by trade. He was a typical case of thrombo-angitis obliterans with a history of intermittent claudication for two years. He smoked twenty cigarettes daily. For about six months he had had an ulcer on the left big toe with severe pain (Fig 12). There was no pulse in the foot and the oscillometer reading at the ankle was faint. In December, 1932, under spinal anæsthesia, the posterior tibial, superficial and deep peroneal nerves were sectioned. There was complete relief of pain. The operative incisions healed by primary union. The ulcer is healing rapidly.

The relief of pain as the result of nerve section presented by every one of the cases detailed is most notable and encouraging. In a few some vague discomfort remained, and some patients complained of occasional sharp, shooting pains for a time, probably due to nerve-end irritation. All of the operative wounds healed by primary union, except in one case of very advanced impairment of circulation (Case VI). In all the operated cases

# THROMBO-ANGIITIS PAIN



Fig 10

Fig 10—(Case XII) Photograph showing ulcers on foot after amputation of gangrenous toes. Four months after operation (November, 1932) Area of anesthesia indicated on big toe (December, 1932)

Fig 11—(Case XVI) Photograph showing healed foot with small residual area of anesthesia indicated

Fig 12—(Case XVIII) Photograph showing ulcer on big toe



Fig 11

Fig 11—(Case XVI) Photograph showing healed foot with small residual area of anesthesia indicated (November, 1932) Note recently healed operative incisions in lower leg



Fig 12

Fig 12—(Case XVIII) Photograph showing ulcer on big toe. Note healed operative scars of nerve section



pulsation at the ankle was absent, and readings with the Pachon oscillometer were very much diminished. In seven of the eight patients in whom the popliteal artery was also closed, healing of the operative wounds was satisfactory.

Such results warrant the conclusion that advanced impairment of circulation need not deter one from proceeding with nerve section, inasmuch as healing of the operative wounds is the rule. Trophic ulceration did not occur in any of our cases, which have been observed for two years following the operation. One small ulcer, due to trauma from a nail in the shoe, occurred in Case I. This healed under the usual method of treatment.

It is difficult to estimate the rate of healing in ulcers, but it is our impression that following nerve section, the rate of healing was accelerated. Due to the loss of sensitivity in the ulcerated areas, more efficient treatment of these wounds was possible. In contrast to the great distress that the patient suffered from dressings before operation, the treatment after nerve section was entirely painless. The wounds could be adequately cleansed with ether and immersed in Dakin's solution. Necrotic tissue or bone fragments could be removed without pain, and gangrenous toes, when well demarcated, could be amputated. When the wound surface became healthy, strapping with adhesive strips was frequently utilized. It is not possible to say to what extent this improved care of the wounds, rather than the nerve section itself, was responsible for the apparent acceleration in healing.

Major amputations were done in four of our cases, in two because of spreading infection and in the other two on account of extensive gangrene. In all of these four cases, nerve section had given satisfactory results as far as the relief of pain was concerned. The significance of this relatively high percentage of amputations must be considered in the light of the fact that almost all of these patients represented very advanced cases of thrombo-angitis obliterans.

Evidence of nerve regeneration was present in all cases in which sufficient time had elapsed after operation. Usually a period of about a year is necessary for complete return of sensation, the time varying with the level at which the nerve section was done. Most of the patients in the group presented have gone to complete healing of the affected foot and are walking without any difficulty. In none of them has there been any return of pain or recurrence of ulceration.

The advantage of nerve section in patients with thrombo-angitis obliterans who have painful ulcers of the foot is apparent in the cases presented above. We wish to make it clear that nerve section is in no way a specific treatment for thrombo-angitis obliterans, and has no place except for the relief of pain of the type due to ulceration or gangrene. It will not relieve intermittent claudication. Since vasoconstrictor fibres are carried in the peripheral nerves, section of these is followed by vasodilatation, as shown by the work of Morton and Scott<sup>5</sup>. Thus the local advantages of a lumbar ganglionectomy are obtained without subjecting the patient to a formidable

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operation, and at the same time relief of pain is far more complete due to section of the sensory fibres. It might be added that peripheral nerve section is so simple and safe, that it can be undertaken by any surgeon, while a ganglionectomy is an operation which requires special skill.

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# PERIPHERAL VASOCONSTRICTION BY TOBACCO AND ITS RELATION TO THROMBO-ANGIITIS OBLITERANS

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FROM clinical observations, very definite opinions have been expressed concerning the relationship of tobacco to thrombo-angitis obliterans

Erb,<sup>1</sup> in 1904, concluded that tobacco smoking was a definite contributing factor to the production of peripheral vascular deficiencies Buerger<sup>2</sup> assigns tobacco smoking as a predisposing cause of thrombo-angitis obliterans and states that it is possible that the use of tobacco may render the vessels more susceptible to special agents, toxic or infectious, but that tobacco is the only cause or the exciting cause is exceedingly doubtful Brown, Allen and Mahorner<sup>3</sup> agree with Buerger Willy Meyer<sup>4</sup> presents tobacco-smoke poisoning as the one etiological factor responsible for the characteristic syndrome of thrombo-angitis obliterans Silbert,<sup>5</sup> in reviewing 289 cases of this disease, is convinced that smoking is the most important contributing factor in producing the disease and that cessation of smoking is an essential therapeutic measure He stated that 50 per cent of the patients requiring amputation continued to smoke in spite of repeated warnings and that recurrence of symptoms after the individual had been restored to good condition was almost invariably traceable to a resumption of smoking In only two of Silbert's cases had a progression of the disease taken place when the patient was not using tobacco Samuels<sup>6</sup> insists that the first point in the treatment of thrombo-angitis obliterans is the absolute prohibition of the use of tobacco

The study by Barker<sup>7</sup> of the tobacco usage at the onset of the symptoms, not that used after severe pain or gangrene, in 350 cases of thrombo-angitis obliterans, shows conclusively that a greater percentage (87 per cent) of the individuals with that disease use tobacco than do other groups, that they smoke cigarettes much more (91.5 per cent) than other forms of tobacco, that as a group they consume more tobacco than other individuals and finally, that the severity of their disease is greater in the excessive users than that in the very few non-users and mild users of tobacco

A considerable amount of experimental work has been done with tobacco and its derivatives In the literature we have found only three investigations<sup>8,9,10</sup> demonstrating the peripheral vasoconstrictor effect of tobacco smoking in man We have seen no reference to these articles in discussions of the possible relationship of tobacco smoking to thrombo-angitis obliterans Recently, in a preliminary report,<sup>11</sup> we presented definite evidence of the peripheral vasoconstrictor action of tobacco smoking in man by means of skin-temperature changes We wish here to report this work in detail

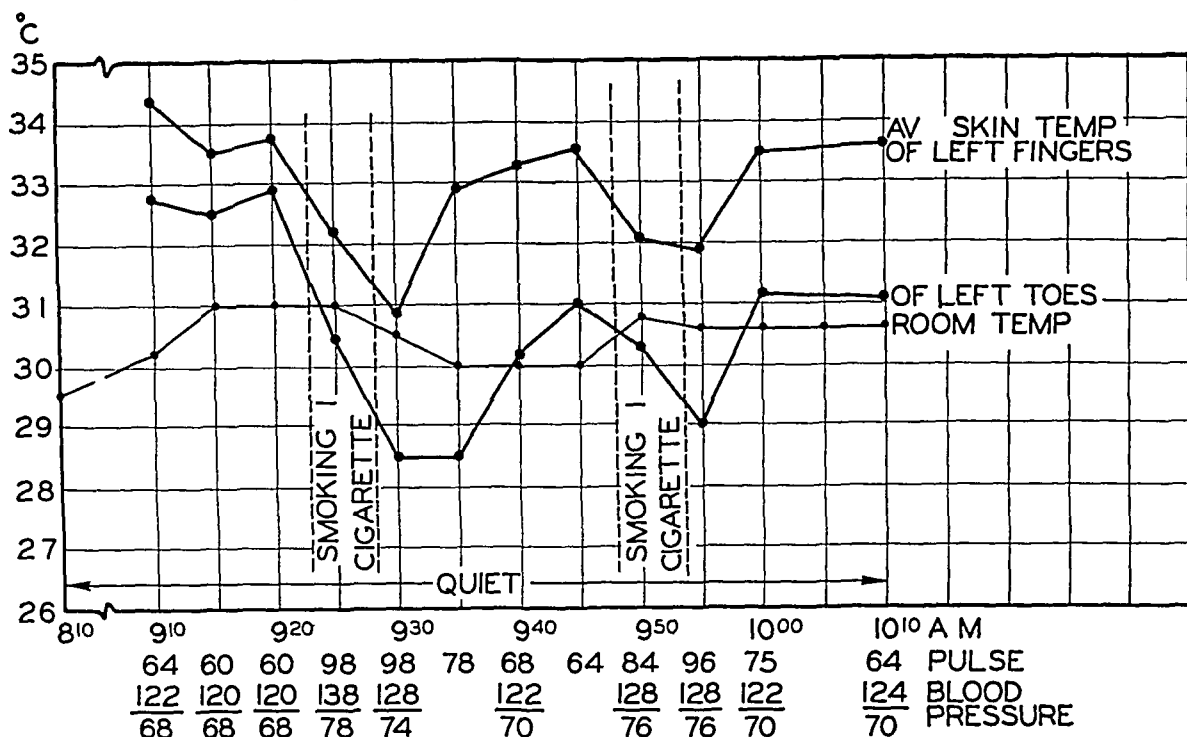
*Normal subjects*—The investigation was carried on in a small room in which the temperature could be controlled at a fairly constant level, the range being from 25.0° to 28.0° C\* A small electric fan running at low

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\* In order to show an increase in peripheral vasoconstriction it was not desirable to have the normal peripheral vasoconstriction at its maximum at the onset of the experiment Accordingly, fairly warm room temperatures were used, under which condition peripheral vasoconstriction is at a low degree or may be entirely lacking

## TOBACCO AND THROMBO-ANGIITIS OBLITERANS

speed provided a circulation of air. No talking was allowed and every effort was made to eliminate psychic factors. The subject, lying quietly on a bed and wearing shorts in the case of the men and shorts and a breast covering in the case of the women, was exposed to the environmental conditions for one hour\*. At five-minute intervals blood-pressure and pulse readings were then made on the right arm and skin-temperature measurements were taken with a "Tycos Dermatherm" on the palmar tips of the left fingers and the plantar tips of the left toes†. On some subjects the skin temperature just above the umbilicus and of the right toes was recorded. After a fairly constant skin-temperature level had been reached the subject was given his customary form of tobacco to smoke at his usual rate. Following completion of the smoking the patient continued to lie quietly in order to determine



C F - AGE 25 - SMOKES 20 CIGARETTES PER DAY - INHALES

FIG 1 —The effect of cigarette smoking on blood pressure, pulse rate and peripheral skin temperature whether the cardiovascular changes that resulted during the smoking period would return to their previous levels. The experiment was carried out with twenty subjects between twenty and thirty years of age, the majority of whom were medical students. Both light and heavy smokers were included in the group.

Under the conditions of the study the data obtained from subject C F and shown in Fig 1 demonstrated that with smoking there occurred an increase in blood-pressure and pulse rate and a decrease in the skin temperature of the left fingers and toes. On cessation of smoking the first cigarette,

\* This initial period was selected in order to allow for an adaptation of the skin temperature to the environmental temperature.

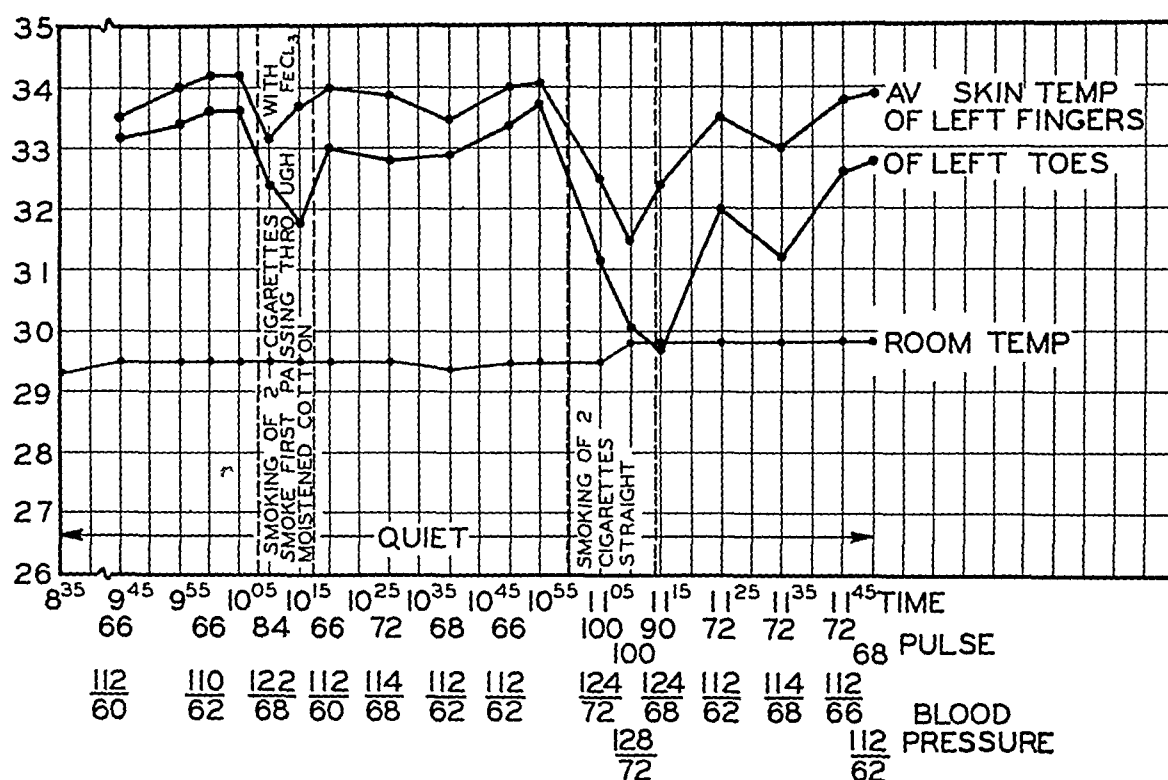
† These measurements were taken routinely on the one side only because it has been repeatedly shown<sup>12, 13</sup> that normally the skin temperature of symmetrical body points is approximately the same.

TABLE I  
*Blood-Pressure, Pulse Rate and Skin-Temperature Changes with Tobacco*

Subject	1 HS	2 CF	3 CH	4 SB	5 CF	6 HJ	7 RH	8 CH	9 MF	10 HB	11 MB
Age	18 F	26 M	23 M	24 M	25 M	25 M	28 M	23 M	29 M	30 M	23 M
Sex											
Average smoking per day											
Cigarettes	20	20	12	20	18	15	20	12	35		15
Pipefuls										6	
Inhalates smoke	+	+	+	+	+	+	+	+	+	—	—
Smoked during test—cigarettes or pipefuls	1	1	2	2	2	3	3	3	2	2	4
Time smoking—minutes	7	5	20	20	14	25	15	25	12	44	25
On smoking											
Increase in systolic B P in mm of Hg	20	18	8	20	16	18	10	10	18	8	10
Increase in diastolic B P in mm of Hg	14	10	25	10	6	16	0	20	10	10	4
Increase in pulse rate per minute	8	38	20	20	34	18	18	16	26	24	12
Decrease in av skin temp left fingers in °C	4 5	2 8	3 0	1 5	2 5	2 2	3 5	6 0	4 5	3 0	0 7
Decrease in av skin temp left toes in °C	2 5	4 5	1 0	3 0	4 0	4 5	0 5	2 0	4 3	2 5	1 6
Time required in minutes to return to level previous to smoking											
Systolic B P	20	12	14	15	10	15	15	12	10	20	4
Diastolic B P	20	12	20	6	10	15	15	12	10	30	2
Pulse rate	20	15	20	5	15	5	15	12	10	30	4
Skin temperature, fingers	5	15	70	20	45	35	20	60	10	40	10
Number of degrees C of the temperature of the toes below their pre-smoking level at the time the temperature of the fingers had returned to their original level	1 5	1 8	0 0	1 5	1 0	2 0	0 0	1 0	3 5	2 5	0 5

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the blood-pressure and pulse rates returned to their previous level in approximately twelve minutes, the skin temperatures of the fingers increased to their previous level in seventeen minutes, while at that time the toes were still  $20^{\circ}\text{C}$  below their original temperature. The same response occurred on smoking a second cigarette. The nineteen other subjects in this group on smoking showed the same changes to a greater or less degree as the example presented. The data from eleven of them are given in Table I. Occasionally a subject noted mild vertigo and nausea on smoking. This was stated to be no greater than often experienced in their usual smoking habits. There were no significant changes in mouth temperature and skin temperature about the waist during an experiment. The magnitude of the changes



C F AGE 25 SMOKES 20 CIGARETTES PER DAY INHALES

FIG 2—A lessened cardiovascular response as a result of the smoke first passing through a filter

in blood-pressure, pulse rate and peripheral skin temperature was greater with rapid smoking than with slow smoking and again with “inhaling” the smoke than with merely “puffing” (Subject 11, Table I)

Subject 9 of Table I, an Austrian Jew, smoked thirty-five to forty cigarettes per day. In spite of this habitual excessive use of tobacco there was a marked cardiovascular response to the smoking of two cigarettes. In subject 10 of Table I the usual changes recorded on cigarette smoking were noted from pipe smoking.

The possibility was raised that some other factor than tobacco smoke was responsible for the result obtained. Accordingly, a series of control experiments was made. These consisted of changing the original conditions of the smoking experiment as follows. First, the substitution of cubebs for cigarettes, and second, by having the subject go through the motions of

smoking with a small paper tube or an empty pipe. With these substitutions there were negligible changes in blood-pressure, pulse rate and peripheral skin temperature. In the third group of controls the smoke was first passed through two water bottles or through a layer of cotton moistened with  $\text{FeCl}_3$ ,<sup>9</sup> thereby removing some of its components. A decreased cardiovascular response resulted, an example being shown in Fig. 2.

The data from these control experiments substantiated our opinion that the increase in blood-pressure and pulse rate and the decrease in peripheral skin temperature found on smoking were due to active products absorbed from the tobacco smoke. This conclusion is in entire accord with the work of Sımcı and Marcu.<sup>9</sup>

The decrease in the peripheral skin temperature of our young adult group on smoking was of particular interest to us. This effect must be due to increased peripheral vasoconstriction. From a contemplation of this fact, several questions arose. We did not attempt to enumerate nor to answer all of them in this study. Of special interest appeared

(1) Through what mechanism does tobacco smoking produce peripheral vasoconstriction in man?

(2) What components or component of the tobacco smoke is responsible for this action?

In 1908, Lee<sup>14</sup> presented the composition of tobacco smoke obtained by an aspirator from the slow combustion of 100 grams of tobacco as follows.

Nicotine, 1.165 grams. This represented 50 per cent of the total nicotine present before combustion. Pyridine bases, 0.146 gram, chiefly pyridine and collodine, the former being produced during the destruction of some of the nicotine, the latter from the combustion of the fibres in the tobacco. Hydrocyanic acid, 0.08 gram, ammonia, 0.36 gram, carbon monoxide, 410 cubic centimetres.

Many ingenious animal experiments support the view that the site of action of a tobacco infusion<sup>15</sup> and of nicotine lies in the vasomotor nervous system. Langley and Dickinson<sup>16</sup> proved that nicotine stimulates sympathetic ganglion cells. Hoskins and Ransom<sup>17</sup> consider the pressor effect of nicotine due about one-half to a stimulation of the vasoconstrictor centre proper in the medulla and one-half to a stimulation of the sympathetic ganglion cells.

A few variations in our original smoking procedure presented data in man in accord with these conclusions. The decrease in the skin temperature of the toes shown on smoking was approximately the same for both feet. On two normal subjects a block of the left posterior tibial nerve with 2 per cent procaine was done at the tip of the medial malleolus. This procedure interrupted the nerve supply to the plantar surface of the left toes. The usual smoking experiment was then started and both subjects showed the same result. On smoking a decrease occurred in the skin temperature of the right toes but did not occur in the left toes where the nerve was blocked.

## TOBACCO AND THROMBO-ANGIITIS OBLITERANS

It was evident, then, that the peripheral vasoconstriction produced by tobacco smoking in these two normal subjects was brought about through the nerve mechanism and was not a direct effect on the musculature of the vessel walls.

This phase of our investigation was furthered by the opportunity to do the smoking experiment on an individual who had had a cervicodorsal ramusectomy and ganglionectomy and a lumbar ganglionectomy for Raynaud's disease. The sympathetic nervous system control to the extremities of this individual was abolished by this procedure. On smoking, the usual blood-pressure and pulse increase were found but no change occurred in the peripheral skin temperature. With this fact in view, we proceeded one step further from the conclusion reached as a result of the nerve-block experiment and considered that the peripheral vasoconstriction produced by tobacco smoking was brought about through the sympathetic nervous system.

*Nicotine*—From animal experimentation Lee<sup>14</sup> concludes that nicotine is the most important poison in tobacco. Cushny<sup>18</sup> considers it to be the only constituent of tobacco possessing any toxicological interest. Sollmann<sup>19</sup> states that the effects of tobacco are due practically solely to its nicotine content and that nicotine is absorbed extremely rapidly from the mucous membranes and especially from the lungs. We were interested then in determining whether nicotine administered by other channels would produce the same effect on blood-pressure, pulse rate and peripheral skin temperature as that shown by our young adults when smoking cigarettes.

A recent study<sup>20</sup> reported the average nicotine content of four popular brands of cigarettes to be 2.2 per cent. Since there is approximately one gram of tobacco in each of these cigarettes, there is an average of twenty-two milligrams of nicotine present.

Several investigators have undertaken the problem of the nicotine content of tobacco smoke and the amount absorbed on smoking.<sup>21,22</sup> Baumberger,<sup>23</sup> from his study, concludes that an average of 0.573 per cent of the weight of cigarette tobacco appears as nicotine in the smoke. Applying this figure along with the consideration that about two-thirds of a cigarette is smoked shows  $10 \text{ by } 66 \text{ by } 0.573 = 3.78$  milligrams of nicotine appearing in the smoke of a cigarette. From a further study Baumberger<sup>24</sup> concludes that 66.7 per cent of the smoke of tobacco is retained in the subject on puffing, and 88.2 per cent on inhaling. He assumes that it is undoubtedly true that nicotine and total smoke would be retained in the same proportion and that therefore 66.7 per cent of the nicotine would be absorbed in puffing and 88.2 per cent on inhaling. Applying these figures the nicotine theoretically absorbed from the smoking of two-thirds of one cigarette on puffing would be 66.7 per cent of 3.78 milligrams = 2.52 milligrams and by inhaling 88.2 per cent of 3.78 milligrams = 3.33 milligrams.

Nicotine has been given in small amounts by mouth<sup>25</sup> without untoward symptoms. Absorption from the respiratory tract is definitely a more direct route to the general circulation than from the gastro-intestinal canal. With the question of the rate of absorption from the stomach and upper intestines there is also the claim that there is some destruction or detoxification of nicotine in the liver.<sup>26</sup> An intravenous administration to the general circulation more closely approximates the respiratory-tract absorption.

Under the conditions of the smoking experiment a total of six milligrams of nicotine hydrochloride was given by mouth at the rate of one milligram in thirty cubic centimetres of water at ten-minute intervals to



two young adult smokers and one non-smoker Other than a mild irritative effect in the mouth and pharynx there were no symptoms The blood-pressure, pulse and skin-temperature changes noted on smoking did not occur We were convinced that minute quantities of nicotine could be given intravenously to smokers with safety Solutions were prepared containing 0.1 milligram of nicotine tartrate or the alkaloid in one cubic centimetre of physiological saline In order to obviate the psychic factor responsible for the momentary peripheral vasoconstriction incident to the puncturing of the vein for intravenous medication, a two-way valve was added

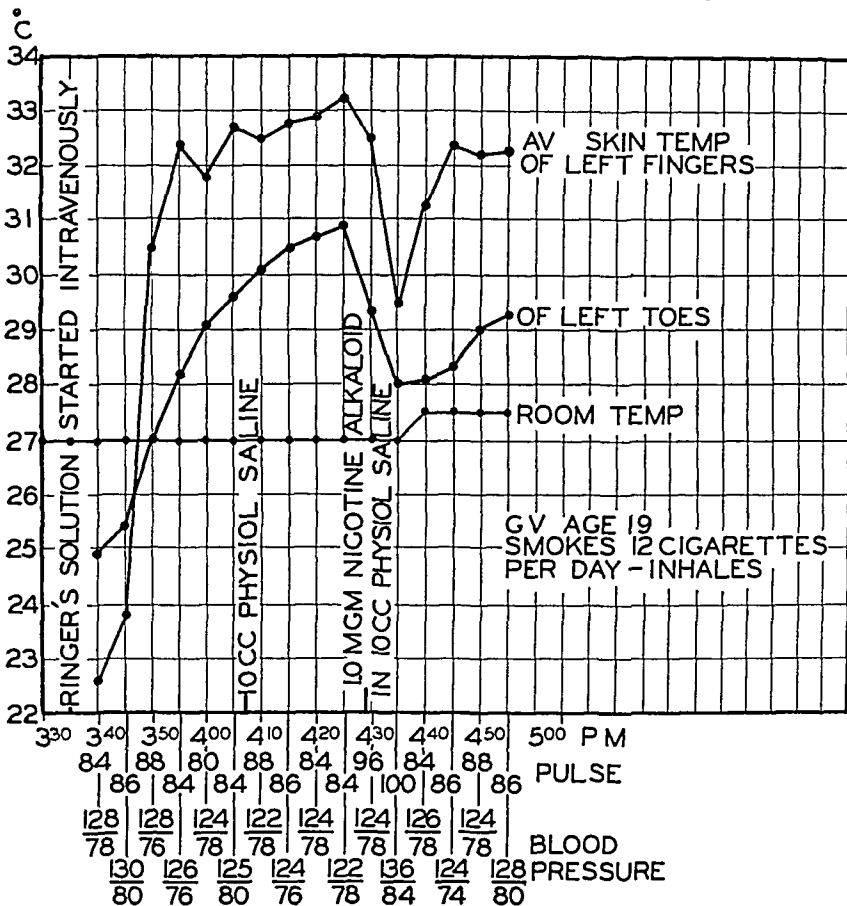


FIG 3—The effect of a 10 milligram of nicotine given intravenously on blood pressure, pulse rate and peripheral skin temperature

to the needle attachment of the burette used for the administration of intravenous fluids Under our standard conditions Ringer's solution was then given intravenously in the left arm at the rate of 150 to 200 cubic centimetres per hour As the subject became accustomed to the procedure the peripheral skin temperature rose to a fairly constant level The valve was then turned and as a control ten cubic centimetres of physiological saline were slowly injected The Ringer's solution was continued for a few minutes and then the nicotine was injected and followed by Ringer's solution to the end of the experiment The data obtained from subject G V (Fig 3), show that on the intravenous injection of one milligram of nicotine there occurred an

# TOBACCO AND THROMBO-ANGIITIS OBLITERANS

increase in blood-pressure and pulse rate and a decrease in the skin temperature of the fingers and toes As in the case of subjects smoking, the effect of the nicotine on the peripheral skin temperature was of longer duration than the effect on the pulse rate and the blood-pressure Also, the skin temperature of the toes showed a slower rise towards their previous level than the case with the fingers In Table II the results obtained with the four subjects of this study are presented

TABLE II  
*Nicotine Intravenously*

Subject	F B	H G	G V	H L
Age	33	18	19	45
	C	C	C	P
Average smoking per day, cigarettes or pipefuls	10	20	12	15
Total nicotine tartrate or alkaloid administered in mgms	6	3	1 5	5
Increase in systolic B P in mm of Hg	16	14	12	12
Increase in diastolic B P in mm of Hg	4	2	6	4
Increase in pulse rate per minute	8	36	16	8
Decrease in av skin temp, fingers °C	4 5	3 5	3 5	2 0
Decrease in av skin temp, toes °C	1 5	0 5	2 7	1 2
Increase in rate and depth of resp with each administration of nicotine	+	+	+	+
Mild aching in left arm	0	+	+	0
Mild vertigo	0	+	0	+
Peculiar taste in mouth .	0	+	+	0

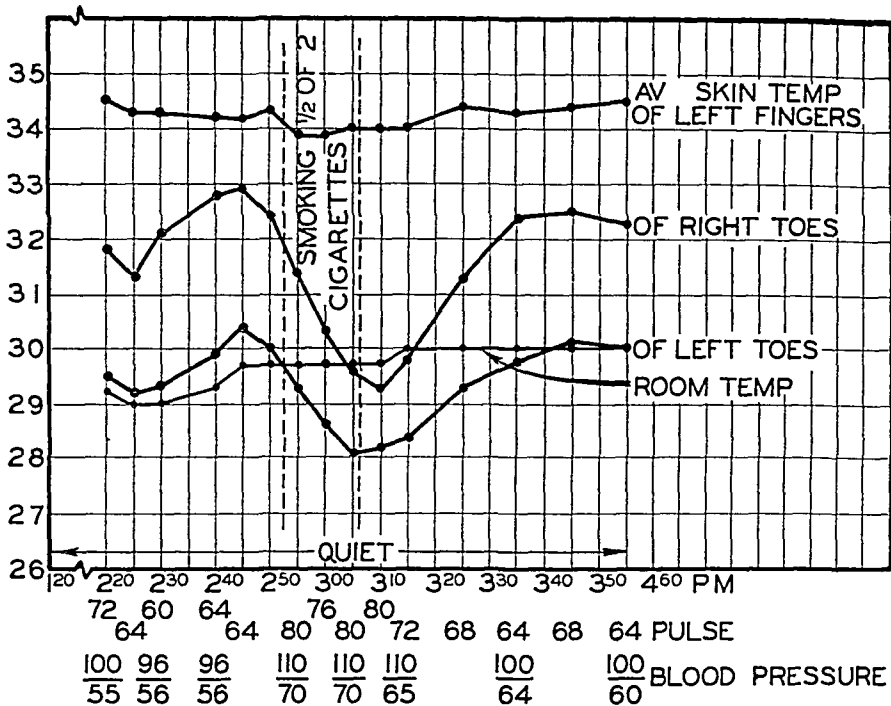
The nicotine administered intravenously was not greater than that theoretically absorbed from the smoking of two cigarettes The data obtained show blood-pressure, pulse rate and skin-temperature changes fairly analogous with those of the normal subjects of Table I This would tend to bear out in man the contention of Lee, Cushny, Sollmann and others that the effects of tobacco are due practically to its nicotine content

*Thrombo-angitis Obliterans*—The application of this investigation to patients with thrombo-angitis obliterans was carried out with considerable interest

In Fig 4 is shown the result of our study on F S, aged fifty years, whose symptoms began fifteen years previously with intermittent claudication of both legs He stated that from 1924 to 1929 he had smoked about ten cigarettes and two cigars a day His general course had been periods of remissions and exacerbations of the intermittent claudications, always worse in the left leg, and with occasional periods of rest pain No ulcerations or gangrene had developed General physical examination was essentially normal, excepting the lower extremities Both legs and feet showed some atrophy of the soft tissues There was pallor of the feet on elevation and rubor on dependency, both being more marked on the left Lower extremity pulses were

	<i>Right leg</i>	<i>Left leg</i>
Popliteal artery	Fair	Slight
Posterior tibial artery	Fair	Slight
Dorsalis pedis artery	Fair	Slight

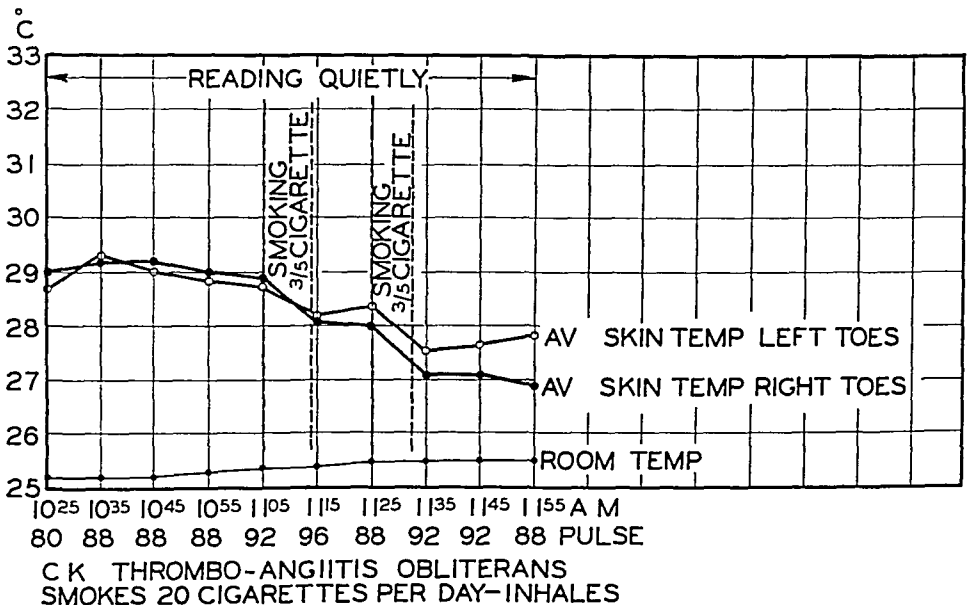
As a result of smoking under the same conditions used for the normal subjects this patient showed a marked decrease in the skin temperature of the toes and an increase



**FS THROMBO-ANGIITIS OBLITERANS  
SMOKES 12 CIGARETTES PER DAY - INHALES**

FIG 4—Cigarette smoking producing an increase in blood pressure and pulse rate and a decrease in peripheral skin temperature (peripheral vasoconstriction) in a patient (F S) with thrombo angiitis obliterans

in blood-pressure and pulse rate. Remembering that clinically the vascular deficiency was greater in the left foot than in the right, we found it to be in accord that the skin



**C K THROMBO-ANGIITIS OBLITERANS  
SMOKES 20 CIGARETTES PER DAY - INHALES**

FIG 5—Cigarette smoking, with the patient sitting in a chair and reading quietly producing an increase in pulse rate and a decrease in peripheral skin temperature (peripheral vasoconstriction)

temperature of the left toes throughout the experiment was lower than that of the right. Also considering that there were probably fewer uninvolved branches of the vascular

bed in the left foot capable of constricting, it was reasonable that, on smoking, the decrease in the skin temperature of the left toes, of approximately  $2.4^{\circ}\text{C}$ , was less than that of the right toes of  $3.5^{\circ}\text{C}$ . From the onset of smoking the skin temperatures of the toes did not return to their previous level for approximately forty-five minutes. Comparatively, there was a much greater response in the toes of this individual over the fingers than was observed in the normal subjects. Interestingly, it was noted that although this man tried to minimize his tobacco consumption by stating that he smoked only half of each cigarette we have never seen a subject inhale the smoke as deeply as in his case.

With a second case of thrombo-angitis obliterans, C. K., the study was carried out under slightly different circumstances. Clinically, the extent of the vascular impairment in each leg was about equal. The patient wearing flannel pajamas sat in a comfortable chair with his legs resting on a low stool. His feet were uncovered. At the beginning of the experiment he started to read a magazine article and was told to smoke when and as he desired. Quietly, skin temperature measurements of the toes were recorded and pulse counts were taken from the right wrist. In Fig. 5 are shown the decreased peripheral skin temperatures and increased pulse rate incident to smoking.

*Comment*—This study made on the effect of tobacco smoking, largely in the form of cigarettes, on young adult smokers, demonstrated a consistent increase in blood-pressure and pulse rate and a decrease in the skin temperature of the fingers and toes. Control experiments gave definite evidence that these effects were due to active products absorbed from the tobacco smoke. Nicotine administered intravenously in quantities not greater than that theoretically absorbed in the smoking of one or two cigarettes produced comparatively analogous changes. Greater effects were noted when the subject "inhaled" while smoking rather than merely "puffing," and also with rapid smoking more than with slow smoking.

The decrease in the peripheral skin temperature on smoking must be due to increased vasoconstriction. In a previous article<sup>13</sup> we pointed out the value of measurements of the skin temperature of the fingers and toes under well-controlled conditions as indications of stimulation or depression of the sympathetic nervous system. In this study the decrease in the peripheral skin temperature was shown to be carried out through that system. While the peripheral vasoconstriction on smoking was usually measured only in the fingers and toes, the points of maximal response to changes in peripheral vasomotor tonus,<sup>13</sup> it is undoubtedly true that vasoconstriction of skin vessels occurred to a lesser degree over the entire body.

By increasing peripheral vasoconstriction smoking reduced the blood supply of the fingers and toes of the young adults studied. With several subjects the reduction lasted more than thirty minutes from the time of cessation of smoking and generally was of longer duration in the toes than in the fingers. In the two cases of thrombo-angitis obliterans cited, smoking produced the same cardiovascular response as in the normal subjects. The already deficient circulation in the feet of these two patients was further reduced by smoking, the decrease in  $F/S$  (Fig. 4) lasting forty-five minutes.

We do not offer the data presented by this investigation as evidence that tobacco smoking is the etiological factor in thrombo-angitis obliterans. The

occurrence of the disease in individuals who have never smoked precludes that opinion. It is interesting, however, to recall that other vasoconstricting substances, pituitrin<sup>27</sup> and particularly ergot, have been responsible for peripheral vascular occlusions and gangrene. Recently Kaunitz<sup>28</sup> pointed out the pathological similarity of thrombo-angitis obliterans and endemic ergotism. In regard to marked vasospasm of neurogenical origin, Spurling, Jelsma and Rogers<sup>29</sup> demonstrated organic vascular changes in the fingers of a patient with long-standing Raynaud's disease. We have no doubt but that prolonged or marked vasoconstriction for a sufficient period of time may initiate organic vascular occlusions. The changes may occur not only in peripheral arterioles, capillaries and venules but also in peripheral arteries and veins as a result of zones of poor nutrition in their walls through vasoconstriction of their vasa-vasorum.

The criterion of a satisfactory result in the treatment of thrombo-angitis obliterans is the avoidance of amputations and the return of the individual to his occupation. Every effort towards that ideal is based on the principle of increasing the peripheral circulation. The demonstrated vasoconstrictor effect of tobacco smoking would lessen or nullify the benefits of all conservative treatment. The experimental data presented form a rational basis for the clinical conclusions as to the deleterious influence of tobacco smoking on the progress of thrombo-angitis obliterans. Its use definitely further decreases the already deficient circulation in the extremities of the individuals with that disease. We unhesitatingly counsel against tobacco smoking by patients with thrombo-angitis obliterans.

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# BASIS FOR RECURRENCE OF VARICES IN THE VARIOUS FORMS OF THROMBOPHLEBITIS

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THROMBOPHLEBITIS of varicose veins as ordinarily observed by the surgeon is seldom followed by permanent obliteration. Clinical experience with post-operative, traumatic, infectious and so-called spontaneous thrombophlebitis has firmly convinced him that recurrence of the varices is to be expected. In a few weeks to a few months the veins are seen to reopen with a return of circulation. In fact, thrombophlebitis is frequently accepted as an etiological factor<sup>1</sup> in varicose veins. Nevertheless, a clinically indistinguishable form<sup>2</sup> of thrombophlebitis produced by the injection of chemical irritants has been found highly satisfactory in permanently occluding varicose veins. The results of my own injection cases during the past four years compare very favorably with the 6 to 15 per cent of recurrences in the thousands of cases reported by Kern,<sup>3</sup> McPheeters,<sup>4</sup> Kilbourne,<sup>5</sup> Forester,<sup>6</sup> O'Neill<sup>7</sup> and de Takats.<sup>8</sup> However, the gratifying results of these experienced men are questioned because of a report in which 98 per cent of sixty-six cases of varices recurred within one year following the injection treatment.<sup>9</sup> Phleboliths and fibrosed veins are sufficient pathological evidence that veins are permanently obliterated by a thrombophlebitic process. The adverse criticism occasioned by the reported 98 per cent of recurrences following injection stimulated the present investigation.

In any case of thrombophlebitis the likelihood of recurrence depends upon recognized physiological principles. The tremendous material now concentrated in the medical centres interested in varicose veins affords unusual opportunity for detailed investigation. The following report of clinical observations and pathological study of a large series of various forms of thrombophlebitis was undertaken to establish a basis for (1) Determining the probability of recurrent varices in any given case, and (2) improving the efficacy of obliterating varicose veins permanently by a chemically induced thrombophlebitis.

*Nature of Thrombophlebitis*—Phlebitis or thrombosis may occasionally occur alone, but, as usually observed, one precedes the other.<sup>10</sup> The resulting clinical picture may include a periphlebitis<sup>11</sup> with redness, swelling, tenderness and increased temperature along the course of a hard thrombosed vein. This may vary according to the size of the vessel and the intensity of the inflammatory reactions. Irrespective of the etiological factor for the thrombophlebitis the same physiological basis for the thrombosis and the same pathological basis for the phlebitis is usually responsible. In the present

discussion I assume that the condition of the blood and circulation is within normal limits. In general, a damaged intima from whatever cause predisposes to thrombosis, and bacterial organisms or chemical toxins to phlebitis. A knowledge of these fundamentals is essential to understand the basis for recurrences of varicose veins.

The primary reaction of blood at the site of ruptured, damaged, or destroyed intima is the liberation of a ferment activating thrombus formation.<sup>12</sup> MacCallum,<sup>13</sup> Aschoff,<sup>14</sup> and Kaufmann<sup>15</sup> state that the "wall of the vessel underlying a thrombus is always injured." At least some interruption of the intima is essential except where clotting is induced by a coagulant<sup>16</sup> and even in these cases the intima is probably injured. I have observed in experimental work that a loosely ligated vessel does not ordinarily become thrombosed.<sup>17</sup> Only when the ligature is applied with sufficient force to break the intima can an obliterating thrombus be expected. When the endothelium is injured by external trauma such as a contusion or ligation, or by internal trauma as infection or injection of chemical irritants, the same physiological process of thrombus formation follows. Activity of the circulation then determines whether a stagnant red clot or a white (or mixed) thrombus will result. The red thrombus is composed of the component parts of the blood in their normal proportions and is somewhat similar to clotted blood *in vitro*.<sup>18</sup> A white thrombus formed in an active circulation is selective in character, in that the platelets predominate with the leucocytes. These platelets are the forerunners of fibroblasts and connective tissue, which ultimately produce fibrosis of the vessel. Bueiger<sup>19</sup> quotes experimental results to show that "when a vessel is ligated no platelet formation could be observed even after the use of caustic irritation, while a typical platelet thrombus develops under such condition in a vessel in which the blood circulates." Many of the contributors to the literature on varicose veins fail to consider this physiological principle. Reclining in active position, ligation, tight pressure bandages are conducive to stagnation and directly interfere with mixed thrombus formation. Instead, a red stagnant thrombus develops which may be absorbed due to the proteolytic action of disintegrating leucocytes. Other factors being equal, more rapid recurrences occur therefore, in post-operative, bacterial, ligation, and injection thrombophlebitis where the activity of the circulation has been retarded.

The origin of the concomitant phlebitis is a matter of considerable dispute. Ordinarily bacteria can be found only in the frank suppurative cases. Of course, it is easily conceivable that a bacteraemia may result in bacteria lodging in a thrombus or in the vasa vasorum and thereby produce the phlebitis. However, it is difficult to believe a bacteraemia and thrombosis to be simultaneously present in such a large majority of cases. The fact remains that in most instances, the exciting organism cannot be isolated. Frazier<sup>20</sup> believes that infection is surely present although the bacteria may have been destroyed or may be of too low virulence to be isolated. Extensive phlebitis is seen following injection of chemical irritants or ligation of veins.



It occurs so generally in certain types of very large veins that I cannot attribute its occurrence to a lack of asepsis. Skin incisions for ligation of varicose internal saphenous veins are almost invariably very slow in healing and have every appearance of a low-grade infection.

Homans' outstanding contributions<sup>21</sup> on thrombophlebitis and lymphangitis stress as important the fact that the lymphatic vessels follow very closely the course of the large venous trunks. Kaufmann maintains that phlebitis is a lymphangitis of the vein wall. The lymphatic channels in the lower extremities constantly convey organisms from the toes, feet and leg to the groin although their presence or source may not always be apparent. The marked tortuosities and dilatations of varicose veins contribute to stagna-

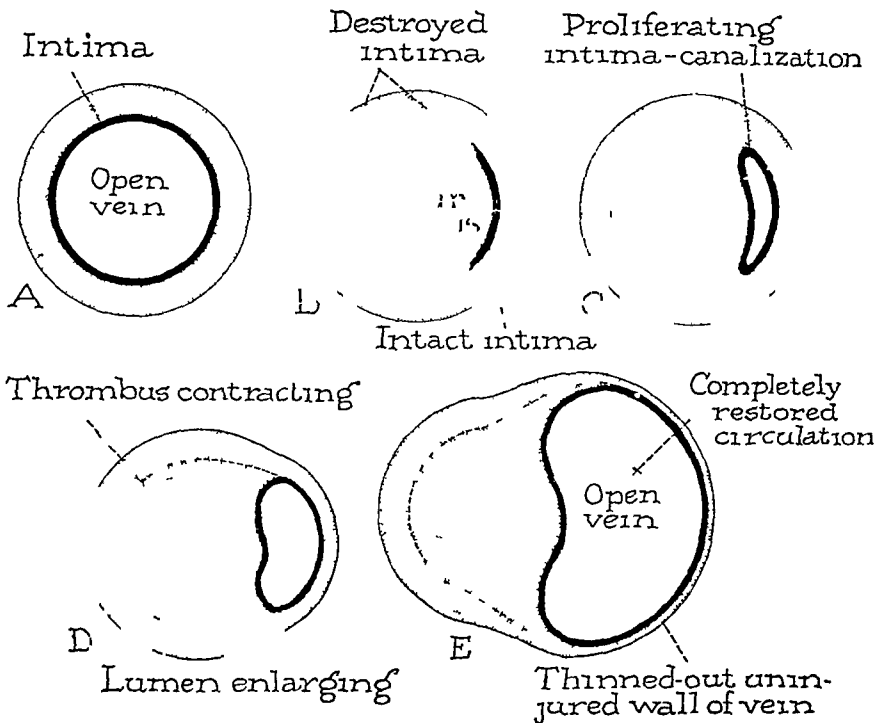


FIG 1.—Diagrammatic explanation of reopening of lumen of a thrombosed vessel. A—Normal vein with intact intima. B—Partial intima destruction with thrombosis. C and D—Proliferating endothelium of intima and contraction of the thrombus away from the uninjured wall of the vein enlarges the recurrent lumen. E—Lumen of vein larger than normal due to the stretching of the thinned out uninjured wall by the restored circulation. Remainder of old vein replaced by contracted fibrous tissue is seen at the left of the new lumen.

tion of the blood circulation and subsequent lowered resistance of the surrounding tissues. A similar disturbance of lymphatic circulation exists with stored-up latent infection. Swelling, induration, fibrosis, eczema, ulceration and infection are therefore prone to occur in these tissues. I am convinced that the same factors, such as trauma, ligation, or injection of chemical irritants, responsible for damaging the intima of the vein, simultaneously activate the latent infection<sup>22</sup> in the accompanying lymphatics. This results in the clinical picture of thrombophlebitis. Clinical experience confirms such a course of events with gradual subsidence of the inflammatory reaction.

*Subsequent Fate of Thrombosis*—The primary obliterating thrombus in every case soon contracts. This contraction is inseparable from fibrin forma-

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tion and occurs whether the clot is in a blood-vessel or in a test tube. With firm attachment of the thrombus to the vessel wall a puckering of the vein and overlying skin is commonly observed, and when insufficient attachment is present, the contraction will leave a space between the wall and the thrombus (Fig 1). Rapid recurrence of varices after thrombophlebitis can be definitely attributed to a shrinking away<sup>23</sup> of a thrombus from the vessel wall (Fig 2). Proliferating endothelium then covers the exposed surface of the thrombus so that the lumen of the vein is reestablished.

Partial or complete absorption of thrombi occurs due to the proteolytic action of disintegrating leucocytes<sup>24</sup>. The larger the proportion of leucocytes present in a stagnant or infectious thrombus the more frequent and rapid will

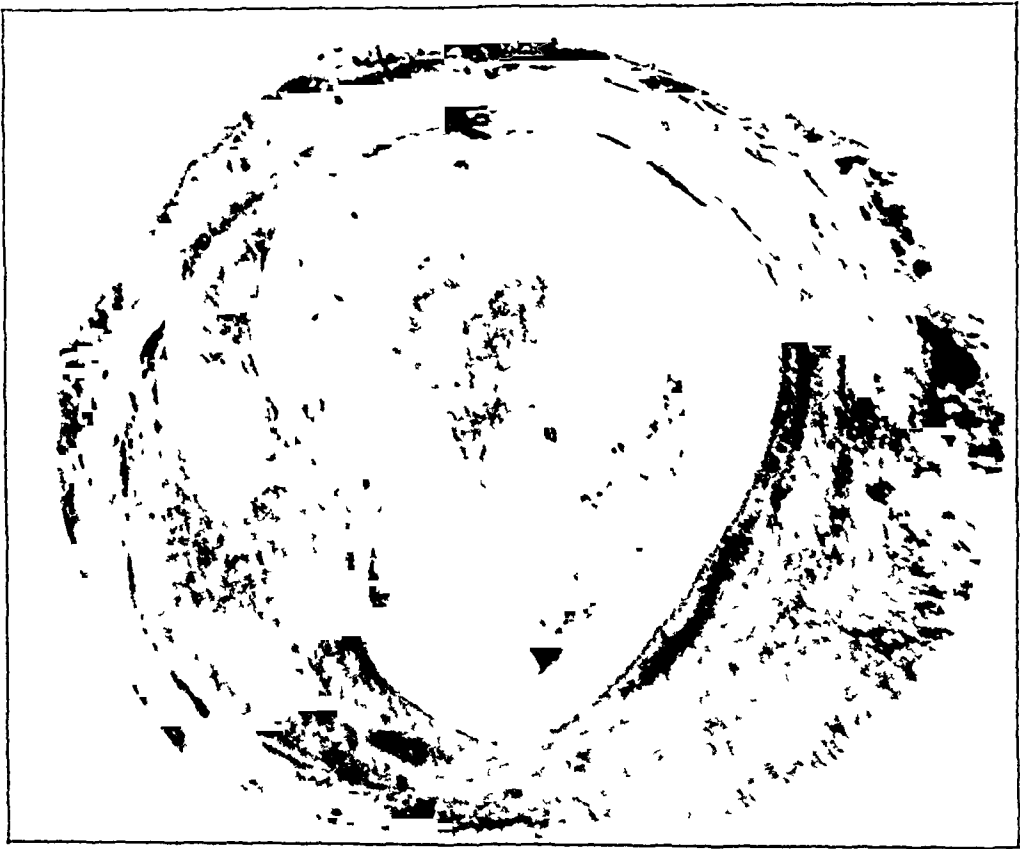


FIG 2—Photomicrograph illustrating E in Fig 1. The restored endothelial lined lumen is filled with blood. The contracted fibrosed thrombus is seen to one side.

be the absorption. Conversely, a selective platelet or mixed clot uncomplicated by infection is less likely to undergo this process. No doubt, many cases of recurrence of varices following thrombophlebitis can be explained on this basis.

Organization of thrombi with or without canalization is the only alternative of absorption. The time required for the changes in the thrombus to take place in this stage is variable. Such factors as the condition of the circulation, general condition of the patient are in the present discussion presumed to be within normal limits. The process of organization involves fatty degeneration and necrosis of the leucocytes, decolorization of the red corpuscle and absorption of the hæmoglobin, and finally replacement of the platelets by fibrous deposits. Accordingly, absence of proteolytic ferments

and the predominance of platelets in a white clot furthers fibrous replacement of a clot. This fibrosis occurs as an ingrowth of vascular granulation tissue from the sub-endothelial connective tissue. As this becomes dense and in the complete absence of intima, contraction of the fibrous tissue will permanently obliterate the vessel. Deposition of lime salts leads to phlebolith formation.

Canalization of an organizing thrombus proceeds from the site of intact intima. Even the report from Holman's clinic<sup>25</sup> discrediting the possibility of obliterating veins permanently by means of a thrombophlebitis fully describes and illustrates recurrences as proceeding from uninjured intima. Solid buds of proliferating endothelium grow into a thrombus, open to

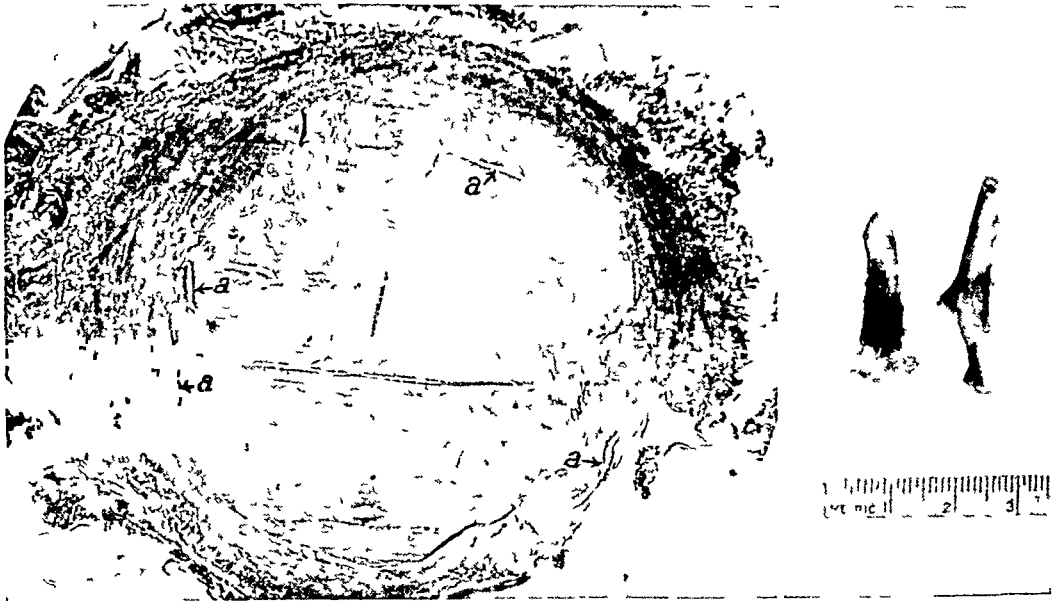


FIG 3A

FIG 3B

FIGS 3A and B—Excised specimens of old fibrotic internal saphenous vein from the site of injection three years previous. (A)—Photomicrograph showing complete fibrosis and a few endothelial lined capillaries (a). In serial sections these capillaries were non continuous and some appeared as blind bloodless areas. Absence of intima accounts for the permanence of the obliteration.

form a lumen, and becoming confluent reestablish the lumen of the vessel. Both Kaufmann and Aschoff emphasize the importance of intact intima for organization and canalization. Naturally, the more intima that remains uninjured in the presence of a thrombus, the more rapidly will canalization and recurrence of the varices proceed. With the intima completely destroyed around the entire circumference of a vein for a considerable distance, reopening of the lumen by this process is not likely. However, isolated blind and bloodless endothelial-lined spaces may be frequently observed microscopically in old fibrosed thrombi. These are easily misinterpreted and reported as canalization unless serially studied or grossly examined. These spaces are due either to non-communicating capillaries supplying the scar tissue or to the metamorphosis of lymphocytes<sup>26</sup> to fibroblasts and then to endothelium<sup>27</sup>. There is a wide difference of opinion among

investigators as to the source of endothelium and fibroblasts Fig 3A illustrates such findings in a thrombus three years old and the spaces are not continuous in serial sections Probability as to the permanency of obliteration in an organizing thrombus depends largely upon the extent and completeness of intima destruction The time required and the degree of recurrence of varices in clinically indistinguishable forms of thrombophlebitis therefore varies

*Critical Analysis of the Common Types of Thrombophlebitis*—As to the possibility of recurrences of varicose veins With a knowledge of the aforementioned clinical and experimental facts a better idea may be had as to what end-results may be expected in any case of thrombophlebitis I will briefly correlate these facts in explaining recurrences in the most commonly observed etiological forms of thrombophlebitis

*Post-operative Thrombophlebitis*—Ligation or clamping of bleeding vessels especially as is seen following pelvic operation<sup>28</sup> may be the point of origin of extensive thrombosis Contusion of varicose veins in handling the patient or in the course of the operation may likewise cause a limited interruption or damage of endothelium with resulting thrombophlebitis during convalescence The presence of an inactive circulation with stasis of the blood in the large veins due to the patient being confined to bed furthers extension of the thrombus Consequently, a typical red clot develops which usually undergoes rapid absorption or organization The possibility of infection except in suppurative cases is not so great as is generally believed although a bacteræmia or contamination at operation may produce an infection of the vessel wall This will be considered under infectious thrombophlebitis Canalization of the thrombus proceeds by proliferation and ingrowth of abundant uninjured endothelium underlying the thrombus In general, therefore, this form of thrombophlebitis is followed by early recurrence of the varices

*Bacterial Thrombophlebitis*—Organisms, from a bacteræmia or from the surrounding tissues, may destroy sufficient intima for thrombosis to occur Confinement of the patient to bed contributes to red thrombus formation The infection still further increases the number of leucocytes in the developing thrombus Proteolytic action of the numerous degenerating leucocytes produces rapid absorption of the thrombus Recurrences of varicose veins are seen within two to four months

*Ligation Thrombophlebitis*—Ligation of varicose veins as an adjuvant to the injection treatment of veins has become quite popular De Takats<sup>29</sup> has been especially enthusiastic regarding this practice although Linser,<sup>30</sup> in the course of 50,000 injections, writes disapprovingly of its use McPheeters<sup>31</sup> also objects to ligation and believes that it contributes to failures in the injection treatment I have observed a number of ligation cases operated by a colleague where in spite of subsequent injections, recurrences of veins commonly occurred (Fig 4) The limited break in the intima due to the ligature gave rise to thrombus formation, but the coincident retarded

circulation contributed to red thrombus formation and rapid absorption. No doubt recurrences are delayed by the ligation but the lack of extensive intima destruction provides sufficient endothelium for proliferation and canalization to occur. Therefore, both absorption and canalization may be expected to hasten recurrences.

*So-called Spontaneous Thrombophlebitis*—No etiological factor can be

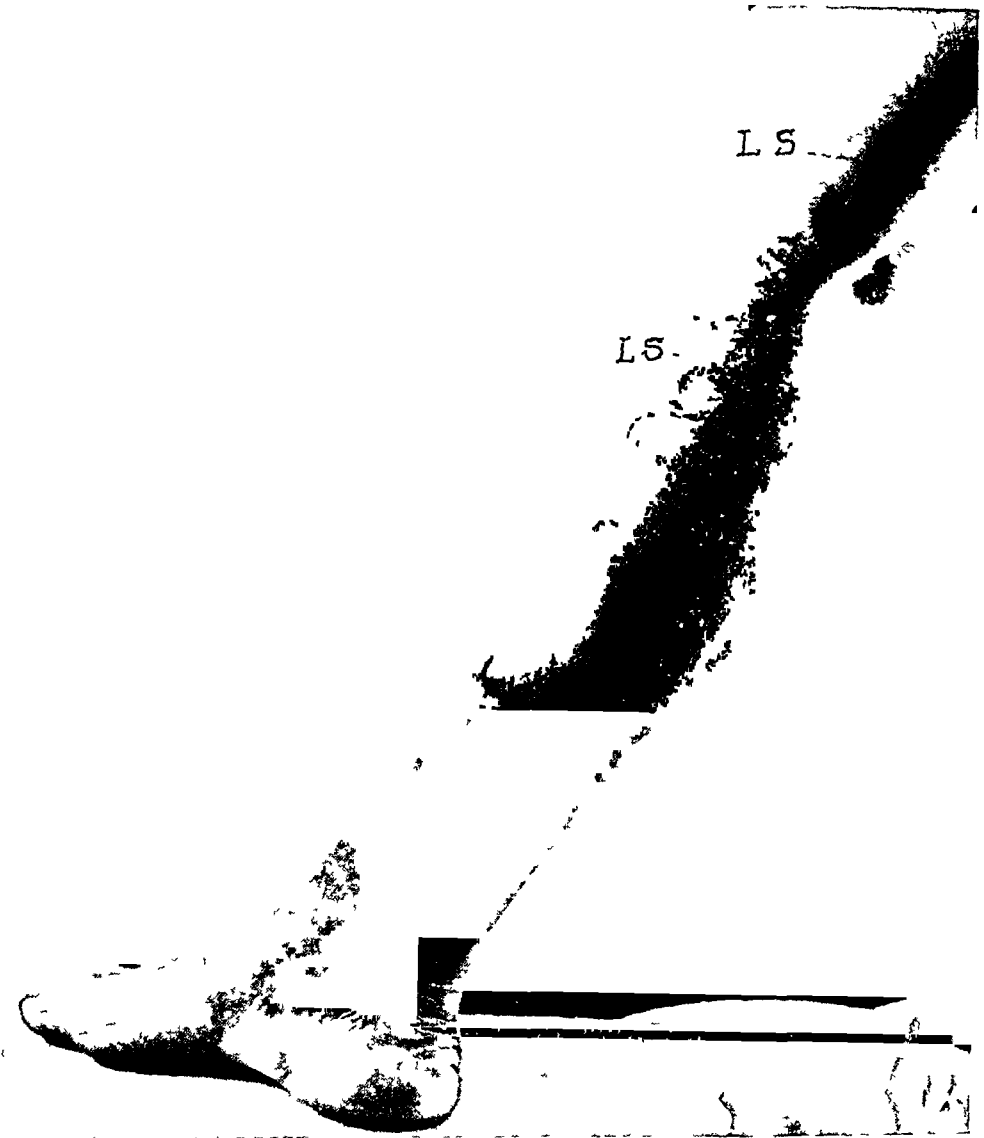


FIG 4—Reopened veins following ligation thrombophlebitis (six months). The site of the ligation scars (L S) is apparent.

found to explain the occurrence of many cases of thrombophlebitis<sup>32</sup>, the absence of any definite cause places these cases in this category. No doubt damage of the intima predisposed to the condition irrespective of whether or not a cause could be found. Theoretically, a healthy individual may have a transitory bacteræmia without its presence being manifest. Also a slight trauma to the poorly nourished tissues around varicose veins may pass un-

noticed. However, the intima damage when the cause is undeterminable is, very likely, limited in extent so that sufficient endothelium remains for proliferation and rapid recurrence of veins. Incapacitating the patient results in red thrombus formation, which further hastens the disappearance of the primary obliterating thrombus by absorption.

*Chemically Induced Thrombophlebitis for Permanent Obliteration of Varicose Veins*—Numerous chemical irritants are advocated for injection into varicose veins to damage sufficiently or destroy the intima for thrombosis to follow. These include hypertonic sodium chloride, sodium salicylate, quinine and urethane, dextrose, levulose-dextrose and sodium morrhuate. Each has been enthusiastically reported in the literature as superior to the others. However, the primary object of any of them is to destroy the intimal lining of the vein. Limited damage<sup>33</sup> of the intima may be followed by a primary obliterating thrombus but its occurrence cannot be held as a criterion as to the permanency of the obliteration. The technic of injection must assure extensive loss of endothelium which is uncertain in the presence of blood dilution. The advocates of the powerful necrosis-producing solutions such as hypertonic sodium chloride or sodium salicylate report a greater percentage of primary obliterating thrombi because these solutions do not require that the veins be completely bloodless. Still, the danger of necrosis and severe pain makes the necessary technic for injection less certain of extensive intima destruction. The less powerful solutions such as the dextrose or levulose-dextrose require a bloodless area but the solution can be safely held in contact with the intima long enough to assure adequate intima damage. The successful use and efficacy of the sugar irritants depend upon the skill and technic employed, as has been fully described elsewhere<sup>34</sup>. The more completely the intima is destroyed the more certain will the primary thrombus permanently obliterate the vessel.

The type of primary thrombus formation is determined by the activity of the circulation. Since we recognize the importance of a platelet thrombus in order to avoid proteolytic absorption the circulation must not be retarded. Adjuvant ligation pressure bandages, recumbent position, elastic bandages, although recommended procedures, directly interfere with the desired platelet thrombus formation. Therefore, the activity of the patient should be encouraged after injection and during the time that complete occlusion thrombosis of the vessel is taking place.

**SUMMARY**—The two essentials for determining the permanency of obliterating thrombophlebitis are (1) the extent and completeness of the destroyed intima predisposing to the primary thrombus formation, and (2) the type of the primary obliterating thrombus.

Extensive destruction of the entire circumference of the intima is essential for thrombophlebitis to obliterate varicose veins permanently by the process of organization without canalization. For injection treatment of varicose veins the technic employed, rather than the solution used, is of greatest importance to achieve such destruction.

Proliferating uninjured intima, where only localized damage has led to thrombosis, will restore the lumen of the vessel. This is the normal physiological process of organization and canalization and is the basis for recurrences in most cases of thrombophlebitis. A stagnant red clot may undergo rapid absorption. Ligation, recumbent position, pressure bandages, or elastic stockings retard the circulation in varicose veins, thereby furthering the formation of stagnant red thrombi.

Activity of the circulation during thrombus formation furthers the development of a white or mixed platelet thrombus. This type is most likely to produce permanent fibrous obliteration of the vein.

Microscopical study of biopsy sections of obliterated veins should take into consideration the site of origin of the thrombus. At a distance from this point the intima is not disturbed and proliferation of the intact intima produces canalization of the thrombus. Permanence of obliteration of varicose veins by means of the injection treatment must be studied from sections removed at the site of the injection of the chemical irritant.

#### CONCLUSIONS

Post-operative, infectious, ligation and so-called spontaneous thrombophlebitis are usually followed by organization and canalization of the thrombus with restoration of the lumen of the vessel. The limited damage to the intima causing thrombus formation and confinement of the patient to bed influences the rapidity of recurrences of veins.

Annular and extensive intima damage in chemically induced thrombophlebitis is necessary for permanent obliteration of varicose veins. Otherwise retraction of the thrombus away from the undamaged wall or proliferation of uninjured intima will restore the lumen of the vessel.

When recurrences are observed another injection at that site should assure destruction of the remaining intima.

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# RENAL NEOPLASMS

REPORT BASED UPON TWENTY-FIVE CASES OF MALIGNANT TUMORS  
OF THE KIDNEY

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THERE are few chapters in urology that are quite as discouraging to the surgeon as the chapter dealing with malignant tumors of the kidney. While malignant tumors occurring anywhere in the body, when considered as a group, give therapeutic results that are far from satisfactory, it is difficult to understand why neoplasms of the kidney offer such dismal prospects as regards end-results following their extirpation. Until such a time when the true causative agent of new growths is ascertained, any advance in the treatment of these lesions must of necessity depend upon bits of information obtained from the clinical observations of physicians actually engaged in treating such cases. Statistical analyses of groups of cases, regardless of their size, coming from clinicians sufficiently interested to carefully record their observations, procedures and results must eventually serve to throw some additional light upon the subject which is at present engaging the patience, skill and ingenuity of cancer research workers the world over. It is for the purpose of placing upon record observations based upon a series of twenty-five malignant tumors of the kidney that this paper is presented.

## CLASSIFICATION OF RENAL TUMORS

I—Tumors of the Kidney Proper (A) Involving Parenchyma 1 Adenoma (a) Cystadenoma (b) Papillary adenoma (papillary cystadenoma) 2 Carcinoma (a) Nodular forms (b) Diffuse carcinoma (c) Multiple carcinomata (d) Lymphangitis carcinomatosis (B) Involving Stroma 1 Benign (a) Lipoma (b) Fibroma (c) Myoma (d) Angioma 2 Malignant (sarcoma) (a) Spindle cell (b) Embryonic Tumors —(1) Adeno-myosarcoma (Birch-Hirschfeld) (2) Adeno-myochondrosarcoma (Wilms) (3) Teratoma (C) Hypernephroma 1 Benign 2 Malignant (Grawitz)

II—Tumors of the Renal Pelvis (A) Of Epithelial Origin 1 Papillary carcinoma 2 Prickle-cell carcinoma (B) Of Connective-tissue Origin 1 Lipoma 2 Lymphangioma 3 Fibrosarcoma

Although some writers classify cysts along with renal neoplasms, they are purposely omitted in this outline because of the fact that the writer considers them as due to retention resulting from inflammatory changes, or to congenital defects rather than to actual metaplastic or hyperplastic cellular changes.

*Adenomata*—Renal adenomata are more of academic interest than of clinical importance. They usually occur in groups in the renal cortex in older

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individuals and give rise to no symptoms. Histologically they appear as clusters of epithelial cells arising from the renal tubules with or without acini. They are white, brown or yellow in color and vary from pea size to the size of walnuts. Occasionally, they undergo cystic changes and are then designated as cystadenomata. They frequently are seen in contracted kidneys. Some of these tumors show papillary tendencies and are then designated as papillary adenomata or as papillary cystadenomata. Papillary adenomata frequently undergo fatty and malignant changes as a result of which they carry a poorer prognosis than do the cystadenomata.



FIG 1—Squamous cell carcinoma. Sagittal view of kidney.

*Carcinoma*—Primary renal carcinomata arise from the epithelial cells of the tubules or of Bowman's capsule, usually occur in one kidney and are not infrequently associated with calculi. These tumors may appear in a variety of forms. The nodular form designated by the Germans as "Knotformen" usually results from renal adenomata which have undergone malignant change. When the carcinoma arises from the tubular epithelium, it spreads diffusely through the renal parenchyma, giving rise to a large kidney, and shows a marked tendency toward infiltration. Such tumors undergo regres-

sive changes such as fatty degeneration, hæmorrhages, calcification and necrosis, which explains the frequent occurrence of cysts within them. Such a tumor bears the designation of diffuse carcinoma of the kidney, or, as the Germans call it, "carcinoma adenomatoides," because of the tendency of the tumor-cells to arrange themselves in pseudo-gland formation. Multiple carcinomata of the kidney are usually secondary or metastatic. They occur as round tumors in the cortex and histologically are of similar construction to the parent growth (Fig 1).

There is a type of carcinoma designated as "lymphangitis carcinomatosa" which is of unusual clinical significance. In this type of involvement, the kidney is secondarily invaded from a primary lesion situated in a neighboring organ such as the stomach or retroperitoneal lymph-nodes, the extension proceeding along the course of the lymphatic channels. It is of interest to note that in the kidneys the lymphatics are closely attached to the walls of the veins but not the arteries, so that in looking for evidence of this type of renal invasion, special attention should be paid to the main venous channels of the kidneys and particularly to the arcuate veins.

*Tumors of Connective-tissue Origin*—The benign group of connective-tissue tumors are of little importance. Lipomata of the renal capsule are common and may attain large size, while those occurring in the renal substance are very rare, usually congenital and appear as small yellow tumors most frequently situated in the cortex. Not infrequently they occur as mixed tumors, namely as lipomyomata or as liposarcomata. Fibromas are also common and appear as small round, whitish, elastic, homogeneous nodules situated in the cortex or medulla. Myomata are most frequently found in the medulla, while the angioma which is exceedingly rare is found on the outer surface of the kidney and usually associated with malignant tumors involving that organ.

The malignant variety constitutes an interesting and important group of renal neoplasms. The majority of them are of congenital origin and occur most frequently among children. They may grow to enormous size and displace most of the abdominal viscera. In appearance these tumors are whitish or pinkish in color, of soft consistency and rich in blood-vessels. Although occurring in adults, the spindle-cell and round-cell sarcomata are also encountered in children. Occasionally they occur in combination with adenomata and are then designated as adeno-sarcoma. The group of embryonic tumors consisting of the adeno-myosarcoma (Birch-Hirschfeld), adeno-myochondrosarcoma (Wilms), and the teratoma occurs practically always in infants and young children. As indicated by their respective designations, they are all mixed tumors.

Various theories have been advanced to explain the origin of these mixed tumors, but the one that seems to bear the most credence is the theory maintaining the incorporation of a fragment of the somatic plate, especially that part which represents the anlage for spine, ribs and muscles into the anlage of the renal parenchyma, with subsequent malignant changes of one or more of the included components. At times these mixed tumors never actually

invade the renal parenchyma but rather grow into the hilus, pushing the kidney aside or invaginating the kidney as a fist would when pushed into a balloon. They show no tendency to invade the renal pelvis, as a result of which urinary symptoms are absent. Any component of the tumor may take on malignant properties, thus giving rise to sarcoma or carcimona, which explains the variation of structure of metastases from these mixed tumors, since the histological architecture of the metastases resembles the parts of the parent tumor which have undergone malignant change.

*Hypernephroma*—Grawitz noted and described a round, circumscribed, well-encapsulated tumor varying in size from that of a cherry to the size of a walnut, of sulphur-yellow color and usually situated in the renal cortex, and designated it as “struma lipomatodes aberrata renis,” believing it due to a congenital inclusion of an aberrant adrenal rest within the kidney substance (benign hypernephroma).

In contradistinction to this benign growth, which is of rare occurrence, there is a malignant tumor of almost identical histological architecture to the benign tumor which for many years has been known as hypernephroma. This tumor differs from the Grawitz tumor in its tendency to invade the renal vein and pelvis and to grow through its capsule. It is this growth which constitutes by far the vast majority of renal tumors and practically always occurs in adults. In size, the tumor varies from that of a nut to the size of an adult head, and shows a great tendency to hæmorrhage, necrosis and softening which accounts for its brownish and reddish discoloration, and also explains the frequency of cavitations within the tumor.

Microscopically, it is almost impossible to differentiate between the benign and malignant forms. Like the adrenal the architecture of this growth consists of a stroma rich in capillaries, and cords or groups of large polyhedral cells, many of which are rich in fat globules. Occasionally the strands of cells arrange themselves in ring formation, the lumina giving them the appearance of glands. Papillary formations are not uncommon. A pathognomonic feature of the malignant hypernephroma cell is its richness in glycogen. This is beautifully demonstrated by staining with best glycogen stain—the glycogen granules appearing red. When stained with iodine the granules turn brown—a reaction shown by no other cancer tissue. To obtain this reaction the tissue must not be soaked in water before staining, since water washes out the glycogen. The specimen is best immersed in alcohol. The foamy and transparent appearance of the cell protoplasm is due to its glycogen content.

A great diversity of opinion exists concerning the exact etiology of the malignant hypernephroma. Opposed to the theory advanced by Grawitz, and supported by Kostenko and others explaining the development of the tumor on the ground of adrenal inclusion, there are such observers as Stoerk, Sudeck, Lubarsch and others who maintain the nephrogenic origin of the growth, stating that the tumor arises from the tubular epithelium of the kidney and has nothing to do with the adrenal gland. Zehbe, for example,

while favoring the nephrogenic origin of this tumor, differs from Stoerk in maintaining that it represents a compensatory reaction on the part of the renal epithelium. In view of the absence of agreement as regards the etiology of the neoplasm, it seems best for the time being to designate the tumor as a nephroma rather than hypernephroma.

*Clinical Course of Malignant Renal Tumors*—The chief outstanding feature of malignant renal tumors is their propensity of breaking into the renal vein so that at autopsy or operation one frequently sees a thrombotic plug laden with tumor-cells projecting into the renal vein and not infrequently into the vena cava. The sites of predilection for metastases which are very common in cases of hypernephroma and renal carcinomata are the lungs and liver. Such metastases can appear years after the extirpation of the primary focus. The skeletal system is not infrequently invaded by metastases from hypernephromata leading to spontaneous fractures and to compression of the spinal cord when the deposits are in the vertebral bodies. Regional lymph-nodes and brain are occasionally involved.

The presence of an associated hydrocele indicates a plugging of the spermatic vein by a malignant thrombus. Occasionally a varicocele may result from pressure of affected nodes or of the tumor itself upon the spermatic vein.

When the tumor breaks into the renal pelvis it makes its appearance there in the form of nodules or polyps which may block the ureteropelvic juncture and lead to the formation of a large hydronephrosis. Necrotic portions of the tumor may become calcified, detach themselves from the tumor mass and pass down the ureter as true concretions.

Invasion of adjacent organs such as the colon, adrenal and diaphragm may occur in the event the tumor breaks through its fibrous capsule. Such an occurrence is not at all infrequent in adults. In cases where tumors have grown to large size there occurs a displacement of intra-abdominal organs, particularly the ascending or descending colon, a condition readily discernible from abdominal examination.

Urinary changes may be entirely wanting in cases of renal tumors, especially in children, where the only symptoms are pain and the presence of a tumor. In the adult the chief outstanding symptom is hæmaturia. This symptom, according to Garré-Borchard (*Lehrbuch d. Chir.*, Leipzig, Vogel, 1920), occurs as an early symptom in 70 per cent of cases. Attacks of renal colic may accompany hæmaturia in the presence of blood clots but as a rule the hæmaturia is painless. Local pain over the affected kidney was seen in 68 per cent of the cases in this series and is usually a late symptom.

*Diagnosis*—While the diagnosis of renal neoplasm is easily made in advanced cases, it may tax the skill, patience and ingenuity of even the most skilled urologists to diagnosticate the disease in its incipient stage. And yet, it is only in the early stages that diagnosis holds forth any hope of ultimate therapeutic success.

Realizing that hæmaturia constitutes the outstanding symptom of this

disease, varying from 70 per cent (Garré-Borchard) to 84 per cent in this series, it becomes incumbent upon the clinician to subject every patient that presents himself complaining of hæmaturia or showing the presence of erythrocytes in the urine to a thorough and painstaking examination in order to locate the source of the bleeding. To treat such a patient expectantly without properly evaluating this symptom is certain to court disaster. Twenty-four per cent of the patients in this series applied for urological study one year or longer after the appearance of symptoms. This in itself is sufficient evidence that hæmaturia is not yet recognized by the general profession as a sufficiently important symptom to warrant a complete urological study. To those familiar with this type of disease, it is not unusual to have a patient state that his initial hæmaturia occurred two or more years prior to operation.

Assuming, then, that a patient presents himself with an initial attack of hæmaturia and is referred for urological study. To the urologist hæmaturia brings to mind four conditions of which hæmaturia is an outstanding symptom, namely tumor, tuberculosis, stone, and so-called idiopathic hæmaturia (calyx-pyelitis). The presence of bladder ulcerations, a moth-eaten appearance of one or more of the calices on the pyelogram and tubercle bacilli in the urine suffice to clinch the diagnosis of tuberculosis. A renal calculus is easily recognized as a positive shadow on the flat plate or in the case of a uric-acid stone as a negative shadow on the pyelogram. In the late stages, with a typical spider deformity or filling defect in the pyelogram, neoplasm is easily diagnosed and often confirmed by the presence of a mass in the loin. In the early stages, however, great difficulty is encountered in making the differential diagnosis between tumor and so-called idiopathic hæmaturia. It is in just such cases that the skill and experience of the examiner are required, particularly in interpreting pyelograms. Upon the proper evaluation of a filling defect in a pyelogram, be it ever so insignificant, may depend the solution of a baffling case and the establishment of a correct diagnosis of a small renal tumor. Yet cases are seen by urologists of great clinical experience where the cystoscope establishes the presence of bleeding from one kidney and yet where repeated pyelograms fail to show any deviation from the normal, and where tuberculosis and stone can be positively eliminated. Just what is to be done in such cases? At times one may note, upon careful reading of a well-taken flat film, a bulge on the convex border of the renal silhouette (Case K J, of this series) which will suffice to warrant operation on the suspicion of the presence of a renal tumor which has not as yet invaded the pelvis or calices (Fig 2). A globular appearance or pear-shaped enlargement of one renal pole seen on the flat film may make the diagnosis, while not certain, at least tentative. Repeated cystoscopical examinations and pyelograms taken at short intervals must be resorted to in cases where unilateral hæmaturia has been found and where the diagnosis rests between tumor and idiopathic hæmaturia. Should no change occur in the urological findings after a lapse of approximately four months, it is the opinion of the writer that exploratory operation is indicated.

This brings up the question of renal exploration and the proper procedure to follow in the event that the surface examination of the kidney fails to disclose the presence of a tumor. Should the kidney be incised and explored or should it be removed? The risk involved in a splitting exploratory operation of a kidney is recognized by any experienced urological surgeon, and while it was a common procedure even up to a decade ago, it is now infre-



FIG 2—Flat plate. Note bulge on the convex surface of the kidney (Operation—adeno carcinoma)

quently employed. This procedure is permissible, however, where on palpation of the kidney any suspicious induration is felt within the renal mass. Yet it is in just such a kidney where in spite of a splitting operation a minute tumor may escape detection and later may be ascertained at autopsy. It appears to the writer that in choosing between an exploratory splitting operation on a suspected kidney with negative findings and a nephrectomy on sus-

picion that a tumor may be present, it is probably better judgment to follow the latter course, provided, of course, the other kidney has been found, prior to operation, to be capable of sustaining life

Absolute diagnosis of so-called idiopathic hæmaturia which most recent investigation has shown to be due to an ulcerating pyelitis involving the terminal calices (calyx-pyelitis) (Ceelen) can be made by the process of elimination or by histological study of the extirpated kidney Nephrectomy in such cases is done either upon the ground of mistaken diagnosis or for the purpose of preventing death from alarming hæmorrhage Chagrin and regret have fallen to the lot of those surgeons who handle urological cases and who are unfortunate enough to have removed a bleeding kidney and to find on careful histological study a calyx-pyelitis The satisfaction, however, derived from finding a small carcinoma around a papilla in a kidney removed upon suspicion of being the seat of a neoplasm partially compensates for the regrets

*Tumors of Renal Pelvis*—The most characteristic tumor involving the renal pelvis is the papillary carcinoma which corresponds in its histological architecture to the papillary carcinoma of the bladder It may grow into the renal parenchyma and be mistaken for a primary renal tumor A tumor of this type found within the renal parenchyma is prima facie evidence that it had originated within the pelvic mucosa

Occasionally one finds a prickle-cell carcinoma within the renal pelvis usually associated with presence of a calculus, or some other form of irritant

Lipomata, lymphangiomata and fibrosarcomata are of rare occurrence within the kidney pelvis The lipoma may be benign or malignant (liposarcoma), the latter giving rise to distant metastases The metastatic deposits are identical in structure to the sarcomatous component of the parent growth, but in addition may show the presence of fat cells which are carried along with the malignant cells in their migration from the parent tumor

Hæmaturia is the initial symptom in the vast majority of cases Secondary hydro- or hemato-nephrosis is of frequent occurrence in pelvic tumors as a result of their tendency to obstruct the ureteropelvic juncture According to Mock (*J d'Urol*, vol III, p 5, 1913), two-thirds of the primary pelvic tumors give rise to this complication Unilateral hæmaturia established by cystoscopy accompanied by a filling defect involving the renal pelvis only suffices to make the diagnosis of pelvic tumor suspicious In the presence of a hydronephrosis the diagnosis becomes more certain

#### STATISTICAL ANALYSIS OF PRESENT SERIES

TABLE I

Symptoms	Number of Cases	Percentage
Hæmaturia	21	84
Loss of weight	14	56
Renal pain	17	68
Tumor	14	56
Varicocele	3	12
Males	17	68
Females	8	32



SUMMARY—Malignant tumors of the kidney occurred three times more frequently in men than in women. The outstanding symptom is hæmaturia, which occurred in 84 per cent of the patients. In slightly more than one-half of the patients there was a history of loss of weight, and in 56 per cent of them a tumor was noticed. Seventeen, or 68 per cent, complained of pain in the affected kidney.

TABLE II

Duration of Symptoms Prior to Operation	Number of Cases	Percentage
1 month or less	3	68
1 to 6 months	11	
6 to 12 months	3	
1 to 2 years	0	0
Over 2 years	6	24
Duration unknown	2	8

SUMMARY—Seventeen patients (68 per cent) have had their symptoms one year or less prior to operation or examination, and of this number eleven (44 per cent) showed symptoms over one month, and three, or 12 per cent, had symptoms over six months. Six patients (24 per cent) presented their initial symptoms two years or longer before the diagnosis was made.

TABLE III

Positive Diagnostic Signs	Number of Cases	Percentage
Tumor	14	56
Deformity in pyelogram	24	96
Reduced 'phthalein concentration	3	12
Blood from ureter catheter	12	48
Varicocele	3	12
Metastases before operation	3	12

SUMMARY—The outstanding diagnostic sign of renal tumor is a deformity in the pyelogram seen in 96 per cent of the cases, while the presence of a palpable tumor was ascertained in 56 per cent. The presence of bleeding, as determined by the passage of a ureter catheter, occurred in 48 per cent. An interesting feature of this chart is the fact that only three patients showed reduced 'phthalein concentration from the affected kidney.

TABLE IV

Age Incidence	Number of Cases	Percentage
First decade	0	
Second decade	0	
Third decade	0	
Fourth decade	1	4
Fifth decade	5	20
Sixth decade	9	36
Seventh decade	9	36
Eighth decade	1	4

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SUMMARY—The largest number of cases seen in this group occurred in the sixth and seventh decades, a combined incidence of 72 per cent

TABLE V

Treatment and Side Involved	Number of Cases	Percentage
Nephrectomy	19	76
Inoperable	2	8
Refused operation	4	16
Post-operative X-ray treatment	14	56
Right kidney	13	52
Left kidney	12	48

SUMMARY—The right kidney was practically as frequently involved as the left (13 to 12) Only two patients of this series were considered inoperable because of the presence of hopeless metastases Of the nineteen patients operated upon, fourteen were subjected to deep Rontgen therapy after operation It is the writer's belief that post-operative X-ray therapy is of positive value in controlling metastases

TABLE VI

Metastases and Complications	Number of Cases	Percentage
Metastases in lungs	11	44
Metastases in liver	5	20
Metastases in bones	2	8
Metastases in scar	3	12
Subphrenic-space infection	1	4

SUMMARY—Most of the metastases occurred in the lungs, 44 per cent , while the liver was invaded in five patients, an incidence of 20 per cent

TABLE VII

Histological Study of Renal Tumors	Number of Cases	Percentage
Hypernephroma of kidney	14	73.7
Adeno-carcinoma of kidney	3	15.8
Adeno-carcinoma of pelvis	1	5.3
Squamous-cell carcinoma of pelvis	1	5.3

SUMMARY—The vast majority of tumors were hypernephromas, 73.7 per cent , while 15.8 per cent showed adeno-carcinoma of the kidney In only two cases were the tumors primary in the renal pelvis

TABLE VIII

End-results—Based on 21 Patients		
Traced	Number of Cases	Percentage
Lived 1 month or less	3	42.9
Lived 1 to 6 months	4	
Lived 6 to 12 months	2	
Lived 12 to 18 months	3	14.3
Lived 18 to 24 months	2	9.5
Lived 2 to 3 years	4	19
Lived over 3 years	2	9.5
Recently operated on	1	4.8

**SUMMARY**—This chart indicated that 57·2 per cent of the patients of this series were dead within eighteen months after the recognition of the disease or after operation, while 28·5 per cent of the patients lived two years or more following treatment. The three patients who died within one month were all old men who apparently died of pulmonary emboli. Eight of the twenty-one patients (38·1 per cent) are still alive, one having passed the six-and-one-half-year limit.

**CONCLUSIONS**—A careful analysis of twenty-five patients with malignant tumors of the kidneys reveals many interesting facts. From a symptomatological standpoint, the outstanding symptom was hæmaturia, which occurred in 84 per cent of the patients. Next in order of importance were pain in the affected kidney, which occurred in 68 per cent, and the presence of tumor in 56 per cent. Three of the eighteen male patients showed the presence of a varicocele, an incidence of 12 per cent. The incidence of males to females was 3 to 1. The greatest incidence occurred in the sixth and seventh decades (72 per cent).

A review of Table II shows the interesting and startling fact that at least 24 per cent of the patients presented symptoms two years or more prior to the institution of the first urological study.

A urological survey conducted upon these twenty-five patients brings to light a few outstanding diagnostic signs. In 96 per cent of these patients a characteristic deformity was noted on the pyelogram. A well-defined tumefaction of the kidney could be felt in 56 per cent of the cases, while bleeding through the ureter catheter introduced into the affected kidney was noted in 48 per cent of the patients. It is of interest to note that although all of the kidneys removed showed far-advanced tumors, the 'phthalein concentration was reduced in only 12 per cent of the cases.

Nephrectomy was performed upon 76 per cent of the patients examined, two cases were inoperable as a result of the presence of lung metastases, while four refused operative relief. The right kidney was involved in thirteen cases (52 per cent) and the left in twelve cases (48 per cent). Fourteen patients were subjected to post-operative deep Röntgen therapy.

Malignant renal tumors metastasize most frequently in the lungs (44 per cent), while the liver is involved in 20 per cent of the cases. Skeletal metastases occurred in 8 per cent of the patients. Recurrence of the tumor in the scar occurred in three patients, an incidence of 12 per cent.

Hypernephroma is the commonest tumor of the kidney, occurring in 73·7 per cent of this series. Adeno-carcinoma occurred in three patients (15·8 per cent). Tumors of the renal pelvis were noted in two patients (10·5 per cent), one being adeno-carcinoma and the other squamous-cell carcinoma.

A review of the end-results in this group of cases indicates that 57·2 per cent of the patients died within eighteen months after the recognition of the disease, or after the institution of treatment, while 28·5 per cent lived two

years or more after operation. Included in the group of patients who died within the eighteen-month period, there were three old men (14.3 per cent) who died of pulmonary embolus. Deducting this number which might be considered as surgical accidents from the group of twelve, we find that 42.9 per cent of the patients actually succumbed from causes directly attributable to the renal tumors within the eighteen-month period. Eight patients (38.1 per cent) of the twenty-one who were traced are still alive, one having passed the six-and-one-half-year limit.

That surgical intervention has a decided place in the treatment of even advanced cases of malignant tumors of the kidney, since most of the cases of this series really were advanced, is attested to by the fact that 28.5 per cent of the patients included in this series lived two years or more after the institution of treatment. Yet, the fact that 57.2 per cent of the patients are dead within eighteen months after operation suffices to indicate that there is something radically wrong in our method of handling such patients. It is the opinion of the writer that one of the chief causes accountable for the poor results following treatment is the failure to recognize the incipient symptoms of this dreadful disease early enough to give the patient the benefit of surgery at a time when it would do him the most good. Could the public and the general practitioner be made to realize the importance of hæmaturia as indicating a serious ailment of the genito-urinary tract, it is certain that a great step forward would be made in the early recognition of renal tumors. It is also the belief of the writer that urological surgeons could by a bolder approach broaden the field of operability in this group of cases, even going so far as to open the renal vein for the purpose of removing a neoplastic thrombus. A carefully planned course of deep Röntgen therapy following extirpation of the diseased kidney carried out over a long period has been found a great aid toward the control of metastases. The early recognition of renal tumors coupled with radical extirpation must lead to a more hopeful prognosis.

# CONGENITAL ABSENCE OF TESTES (ANORCHIA)\*

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FEW reports have been made concerning the absence of testes. In the last two decades such instances have been reviewed in Dutch and German literature, but not in English, so far as we have been able to discover. We believe, therefore, that in addition to a description of the two cases we have observed, a review of nine previously reported is justifiable.

## CASES REPORTED FROM THE LITERATURE OBSERVED AT NECROPSY

CASE I—Cabrol, in 1564, performed necropsy on a man hung for rape. He was unable to find any testes.

CASE II—An anonymous author in 1732, in dissecting the body of a youth who had been found dead on the street, found complete absence of testes. (Cited by Koopman and by Wildbolz.)

CASE III—Kretschmar, in 1801, dissected the body of a child who had lived eight days. The scrotum was empty, and there was complete anal atresia; the child had passed meconium and feces in the urine. The testes, spermatic cords, and seminal vesicles were absent. An abnormal opening through the prostate gland connected the rectum and urethra.

CASE IV—The first American case was described by Fisher in 1839. A man, aged forty-five years, had died of pneumonia. Immediately after birth, the diagnosis of "natural castrate" had been made. He had never had sexual desire. Necropsy revealed a somewhat feminine habitus, with little facial or pubic hair. The penis was the size of that of a ten-year-old boy. The scrotum was small and did not contain testes; the tunica dartos, tunica vaginalis communis, and cremaster muscles were normal on both sides. The vas deferens ended on the left side in a small nodule thought to be the epididymis; on the right side, the vas ended in a small, sac-like dilatation. The spermatic arteries and veins were so small they were found with difficulty.

CASE V—Friese, in 1841, examined a full-term fetus at necropsy. External genitalia were absent, and there was no trace of testes, epididymis, spermatic cords, seminal vesicles, or prostate gland.

CASE VI—Le Gendre and Bastien, in 1849, found at necropsy of a full-term fetus, a small scrotum. The inguinal rings were closed, and a spermatic cord was present on each side, starting at the external opening and ending blindly in the scrotum. Vasa deferentia, seminal vesicles, and other organs were normal. No trace of testes or epididymis was found in the body.

CASE VII—Godard, in 1860, performed necropsy on a man, aged sixty-one years, whose voice and habitus had always been of feminine type. He had never had intercourse, he had no axillary or pubic hair, or beard. The penis was thirty-five millimetres long. There was no scrotum, and the inguinal canals were empty. No trace of testes or epididymis could be found. The vasa deferentia ran from the prostate gland around the urinary bladder, ending blindly in the peritoneum behind both inguinal regions. The spermatic vesicles were present.

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# CONGENITAL ABSENCE OF TESTES

## CASFS FROM THE LITERATURE OBSERVED AT SURGICAL EXPLORATION

CASE VIII—Wildbolz, in 1917, reported the case of a man, aged twenty years, without testes. He had never had mumps or any other infectious disease. A change of voice had not occurred, he had never had erection, libido, or seminal emissions. A physician was consulted because of a drawing sensation in the groin. He had a feminine habitus, and no facial, axillary or pubic hair. The prostate gland and seminal vesicles were not palpable, the penis was only four centimetres long. The scrotum was very small, testes were not palpable in it or in the groin, hernias were not present. Under anaesthesia, bilateral inguinal incisions were made and both inguinal canals were widely opened. A small but complete left spermatic cord reached well into the scrotum. The vas deferens was 2.5 millimetres in diameter, ending in a small rounded mass of connective tissue, ten by eight by four millimetres. A similarly well-developed spermatic cord was found in the right inguinal canal, ending at the neck of the scrotum, but without any swelling at the peripheral end of the vas deferens. The abdominal cavity in the region of both internal inguinal rings was thoroughly palpated but a structure could not be found that in any way resembled a testis. Microscopically, the nodule at the end of the left vas deferens was found to be mostly fibrous tissue containing a few atrophic tubules, perhaps the remains of an epididymis.

CASE IX—Koopman, in 1930, reviewed the subject of congenital anorchia, and added one case proved by operation. Twins, aged thirteen years, were brought to him in 1922, both were feeble-minded, and each had a small penis, a small empty scrotum, without testes palpable in the inguinal canals. Shortly afterward, one of the boys was operated on for acute appendicitis. No trace of a testis could be found in the inguinal canal or in the abdomen. The spermatic cord was present on both sides, but with small vessels, ending in the skin of the scrotum. The prostate gland was present, but the seminal vesicles were absent.

## CASES OBSERVED IN THE MAYO CLINIC

CASE X—A boy, aged fourteen years, was brought to the clinic in August, 1931, because the testes had never descended into the scrotum. His father had died of carcinoma of the bladder. The boy had had mumps, chicken-pox, diphtheria, and scarlet fever. Hernias had not been noticed, but he had recently complained of occasional pains in the inguinal regions. For about ten years, the boy had been given various proprietary pills to "force the testes down." His general health was excellent.

The patient was well developed and well nourished, was sixty-two inches tall, and weighed ninety-six pounds. The blood-pressure in millimetres of mercury was 128 systolic and 78 diastolic. The penis was infantile, the scrotum poorly developed, and the symphysis pubis was covered by a large pad of fat. Laboratory examinations of the urine and blood, including complement fixation, gave negative results. The von Pirquet test was negative, stereoscopic roentgenograms of the thorax were negative.

The right inguinal canal was opened and explored. An external inguinal ring was not present. In the inguinal canal was found what appeared to be the vas deferens, extending throughout the length of the canal, and terminating as an atrophic cord as it neared the pubis. The entire right lower abdominal region was explored, but no testis or vestige thereof was found. The inguinal incision was closed. Through a left inguinal incision, the left lower part of the abdomen was explored, with similar results except that a structure resembling the vas deferens was not found.

CASE XI—A boy, aged eleven years, was brought to the clinic by his parents in August, 1931, because neither testis had been palpable in the scrotum. Three children were living and in good health, another had been born dead. The parents and their immediate ancestors were without inheritable disease or deformity, so far as could be ascertained. The boy's birth had been normal, and he had always been well except for measles, whooping cough, and influenza.

The patient was well nourished, was fifty-nine inches tall, and weighed ninety-two pounds. The blood-pressure was 120 systolic and 65 diastolic. Testes were not palpable in the scrotum or elsewhere. Hernias were not found and, because of the preceding case, it was suspected that testes would not be found at operation. The penis seemed to be normally developed for his age. He coughed, and a few scattered fine râles were heard at the base of each lung, stereoscopical roentgenograms of the thorax were negative. The complement fixation tests for syphilis were positive on specimens of blood taken on two separate occasions, as follows: Kline 2+, Kahn 2+, Kline 1+, Kahn 3+. The patient was sent home for two weeks until his cough ceased, when he returned and operation was performed.

The right inguinal canal was opened under gas anæsthesia. Testis, spermatic cord, or hernial sac were not found in it. When the peritoneum was incised, a small vas deferens could be palpated which ended at about the site of the internal abdominal inguinal ring in a small fatty nodule, apparently a rudimentary epididymis. From this region, the vas deferens could be followed as it ran posteriorly beneath the peritoneum, but no testis was found. The incision was enlarged so that the corresponding region on the left side of the abdomen could be palpated from within. There, similar structures were found, a small vas deferens ending in a rounded fatty nodule, but no testis. The right inguinal incision was closed after exploration.

*Comment—Rarity of Anorchia*—Since the testes may lie within the abdomen or in the inguinal canal without being palpable, it cannot be determined definitely by general examination that both testes are actually absent. The true anatomical condition can be accurately ascertained only by surgical exploration or by necropsy. Besides the eleven cases described, other cases have been noted in which the absence of testes was suspected without this anatomical proof. At least ten such cases have been recorded: two were observed at The Mayo Clinic. According to reviews by Gruber and by Meyer, only about twenty-three cases have been described in which one testis was absent, as demonstrated by necropsy or surgical examination. The two cases which we now report were observed at the clinic in the same month.

*True Anorchia*—There is a possibility that one or both testes might have been overlooked in some of the cases. The detailed description of observations at necropsy seems to indicate sufficiently accurate and careful search so that testes would have been found if present. Such thorough examination of the patients who were operated on was not possible. However, Scammon has stated that after the third month of fetal life, the testis lies in the iliac fossa. Felix has demonstrated that a testis, if present, will be found in the region of the internal inguinal ring and thus will be easily palpable. Undescended or ectopic testes do not lie in the region of the kidney, as was previously believed.

Embryonic remains may be found microscopically along the path which the testis would take in its descent. If such remains are found, their presence may be taken as fairly good evidence that the testis was never formed.

*Cause*—In our two cases the congenital absence of testes might have been due to pre-natal atrophy resulting from intra-uterine disease or trauma, or partial or total failure of embryonic development of the sex glands.

Our first patient had had mumps, the second patient had a weakly positive

complement fixation test for syphilis. Although either of these diseases might have caused inflammation of the testes, neither patient had ever had symptoms of scrotal, inguinal, or abdominal inflammation, so far as we could learn. Furthermore, it is almost inconceivable that any disease process could occur, either before or after birth, which would not leave some remnant of tissue which could be identified. Bagg, even after causing extensive hematomas of the testis in mice embryos by exposure *in utero* to Rontgen-rays, has always been able to find remnants of degenerated testicular tissue. On the other hand, Wangenstein, 108 days after ligating the internal spermatic artery and veins of dogs, found the parenchymal and interstitial tissues of the testis completely replaced by fibrous connective tissue, but he mentioned that in at least one animal the epididymis was normal. Wangenstein also found fibrous connective tissue completely replacing the testis of a youth, aged nineteen years, six years after all vessels except those accompanying the vas deferens had been divided in the performance of orchidopexy.

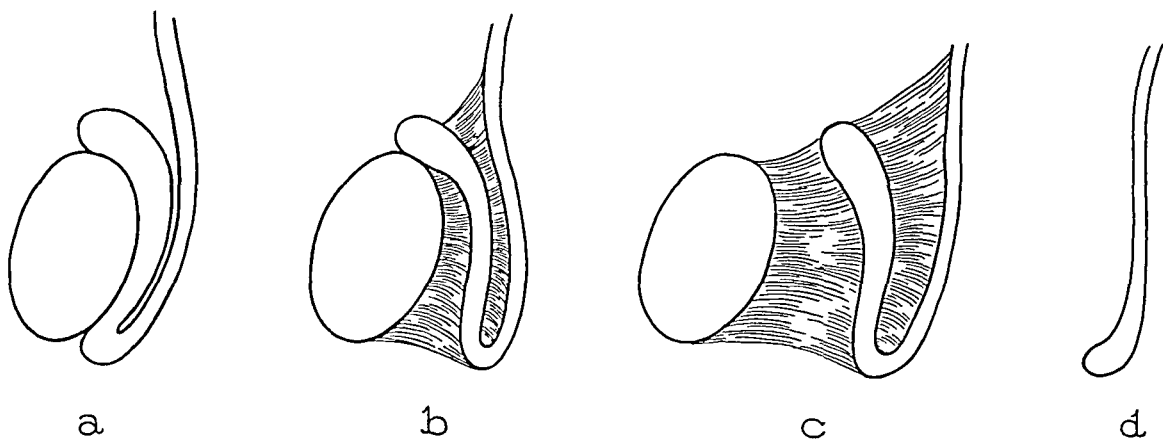


FIG 1—Degrees of separation, as occurring in cryptorchidism

In the cases of anorchia in which the vasa deferentia terminated in small nodules of tissue (Cases IV, VIII and XI), these nodules were reported by the observers to resemble epididymal rather than testicular structures, although this opinion was based on histological study only in Case VIII. The presence of vasa deferentia leading in the direction of the inguinal canals (Cases IV, VI, VII, VIII, IX, X and XI) might suggest normal embryonic development followed by disappearance of the testes, perhaps by interference with the blood supply comparable to that of Wangenstein's experiments. The spermatic vessels, however, were present in four of these cases (Cases IV, VI, VIII and IX).

Pólya, in 1902, described an embryonic variation at the site of attachment of the epididymis to the testis as occurring in cryptorchids, with three degrees of separation (Fig 1, *a*, *b* and *c*). The frequency of different degrees of separation of the epididymis from the testis in the mesorchium has been confirmed by Eccles, Moschowitz, Frattin, Zipper and Wangenstein. Perhaps the cases of anorchia represent a fourth and final degree of separation, with resulting atrophy and disappearance of the testis (Fig 1, *d*). The belief that anorchia is a developmental defect, not caused by pre-natal disease, is



strengthened by its association with congenital absence of the external genitalia (Case V), and with anal atresia and recto-urethral fistula (Case III), the latter is a relatively common abnormality

*Hernia and Anorchia*—When the matter of hernia was mentioned at all (Cases VI, VIII, IX, X and XI), it was stated definitely that hernia was not present. Eccles found that more than half of all patients with cryptorchidism had an associated inguinal hernia. Therefore, if hernia is absent and the testes are not palpable, it should be remembered that, although the testes are probably only undescended, they may be completely absent. This is of clinical significance, and should be mentioned to such patients or their relatives before orchidopexy is attempted, thus avoiding considerable explanation if testes should not be found.

*Effect of Congenital Anorchia on the Development of Secondary Sexual Characteristics*—Three of the subjects described were infants (Cases III, V and VI), and three others (Cases IX, X and XI) were too young to draw any conclusions in regard to the effect of the lack of testes on the development of the secondary sexual characteristics. The first patient described was hung for rape, but no further information is available. Details of the second case were not given. Three subjects (Cases IV, VII and VIII) had definite failure of development of beard and change of voice, lacked libido, and had a feminine habitus. It has been known for centuries that these secondary sexual characteristics fail to develop when the testes have been removed before puberty. Hirschfeld has described the appearance of some of these characteristics subsequent to removal of sex glands after puberty. In cryptorchidism, on the other hand, although spermatogenesis is practically always absent, the secondary sexual characteristics usually develop normally. If a boy does not have palpable testes, however, no attempt should be made to distinguish cryptorchidism from anorchia. If the testes are not in the scrotum, Wangenstein and others have emphasized that the optimal time for placing them there surgically is between the ninth and eleventh years, after any possibility of delayed spontaneous descent has passed, and before puberty, which should normally be associated with spermatogenesis and the advent of the secondary sexual characteristics.

*Summary*—Eleven cases of congenital absence of both testes have been described, including two of our own. The possible causes of anorchia have been considered, but no definite conclusion has been reached. The only constantly associated physical finding, in addition to inability to palpate the testes, is absence of a congenital inguinal hernia, but this is also frequently absent in simple cryptorchidism.

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# EXTRAVESICAL URETERAL OPENING CAUSING URINARY INCONTINENCE

By THOMAS N HEPBURN, M D

OF HARTFORD, CONN

URINARY incontinence caused by an extravesical ureteral opening is a great misfortune to its unhappy possessor, but if diagnosed, it can be easily cured by surgery. Its rarity makes it a most intriguing example of congenital pathology. Therefore, I am reporting the following case, analyzing the previously reported cases, reviewing the embryology, and drawing conclusions based on this study.

Mrs H S, age twenty-five, married, U S, was admitted to the Hartford Hospital September 29, 1932, with a history of urinary incontinence.

Both parents were deaf and dumb. Her past history shows a very healthy life with the exception of the disabilities connected with her urinary incontinence. Married four years—three living children, the youngest three weeks old.

*The present illness* dates as far back as she can remember. She has had to wear a pad all the time, but she voids normally as well. She is a pretty, well-built, vivacious young woman—very fond of dancing, and volunteered the observation that she could keep dry as long as she danced. When she sat down after dancing she would immediately wet herself. In order to cure this difficulty she has had her bladder explored, without benefit, when she was sixteen at a large New England Hospital, and when nineteen had been under observation for two weeks at another excellent diagnostic centre where she was cystoscoped by urologists. The cause of her disability was not discovered. Feeling that she had consulted the highest authorities, she had given up all hope of relief. She entered the Hartford Hospital to be delivered of her third child. She was brought to the

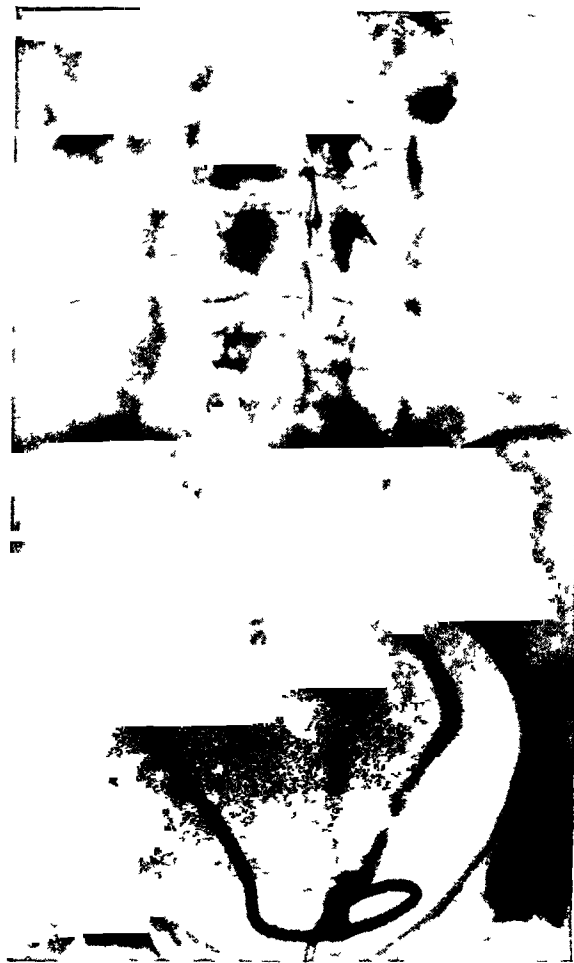


FIG 1—An X ray with a catheter up the right ureter and skiodan injected up both ureters. Note the club shaped foetal pelvis of left kidney and the ureteral shadow running out under the pubic arch.

attention to the Urological Department after her delivery.

Local examination revealed a supernumerary ureteral opening in the vestibule in the midline just below the external urethral opening. I could not catheterize this opening because of its minuteness but I did succeed in injecting skiodan through a small hypodermic needle. The picture is seen in Fig 1. It will be noted that this patient has

## URETERAL OPENING CAUSING URINARY INCONTINENCE

a normal right kidney I searched for a normal left ureteral opening in this woman's bladder on two occasions but failed to find it My pre-operative diagnosis was that this woman had a normal right kidney, and a double left kidney Neither of the left kidneys was functioning, and the top kidney was of the rudimentary type and had an ectopic ureter opening in the vestibule I advised left nephrectomy because I could get no evidence of a functioning lower left kidney This advice was accepted The operation was exceedingly simple, the kidney was hardly larger than a large lymph-gland (Fig 2) It was a double kidney—each kidney being of the rudimentary type

*Report on pathological specimen* by Dr Ralph E Kendall of the Pathological Department of the Hartford Hospital Congenital anomaly of kidney Double kidney Double ureter The specimen consists of a kidney, 6 by 3 by 2 centimetres, with double ureter attached The surface is lobulated The capsule is slightly thickened and adherent in focal areas On section the upper pelvis is divided into three rudimentary calyces There is a slight relative dilatation and its capacity is estimated to be at 2 cubic centimetres Renal parenchyma averages 1.5 centimetre in thickness A narrow, but well-defined, cortical structure can be seen There is a sharp, fibrous



FIG 2—Double kidney after removal Note the undeveloped form The extravesical ureter going to the upper kidney

margin separating the renal parenchyma of the upper and lower portions The inferior pelvis is somewhat smaller and likewise is divided into three rudimentary calyces It is estimated to have less than 1 cubic centimetre volume The brownish parenchymal tissue averages 5 millimetres in thickness and no cortical markings can be identified in the gross The upper ureter is 7 centimetre in length and 5 millimetres in diameter The lower is 5 centimetres in length and 4 millimetres in diameter Each contains a well-defined lumen and smooth mucous membrane

Section of the upper pole of the kidney shows a parenchyma that is essentially normal in character The glomeruli are intact The convoluted tubules show a normal cuboidal type of epithelial lining A few of the tubules are slightly dilated and some contain an amorphous pink-staining material There is no inflammatory involvement and no definite fibrosis There is a sharp, fibrous tissue capsule separating the upper and lower portions of the kidney In the lower pole there is an extensive diffuse fibrosis through the parenchyma separating and distorting the tubules Many of the tubules are atrophic, others are slightly dilated with an atrophic lining epithelium Glomerular tufts are very few, only one-half dozen being found in several sections These are atrophic and fibrotic Both ureters and pelves have a normal micro-

scopical structure The epithelial lining is characteristic and a smooth muscle coat, though somewhat atrophic, is complete No inflammatory reaction is seen

*Analysis of Previously Reported Cases*—This congenital error has been reported 103 times—thirty-nine at autopsy, sixty-four in the living Thirty-three cases were in males and seventy cases were in females Of the cases found in males thirty-one were found at autopsy Only two were recognized in the living—Day's and Chute's cases

*The Locations of the Extravesical Opening in the Male Cases Were* In prostatic urethra, twenty-four cases, in prostate, two cases, in seminal vesicle, five cases, in ejaculatory duct, two cases The reason why it is discovered in males largely at autopsy is because the fluid from the extravesical opening finds its way into the prostatic urethra and is forced back into the bladder by the strong external sphincter, so that there is no incontinence Of the seventy cases in females, nine were found at autopsy

*The Locations of the Extravesical Opening in the Female Cases were* In the vestibule near urethral meatus, fifty-three cases, in the urethra, twelve cases, openings not found, five cases

*Type of Kidney Having Extravesical Ureteral Opening*—Wherever the renal end of an extravesical supernumerary ureter has been described—either by pyelogram, or at renal exploration, or at autopsy—it has been described as ending in a rudimentary kidney or pus sac with rudimentary renal cortex Wherever the renal end of an extravesical ureter leading to a single kidney has been described, we find that three led to fused kidneys—one led to a sac, one was atrophic In the other cases no description of the kidneys is given

*Embryology*—The embryological development of these extravesical ureter openings gives an explanation for their occurrence and a suggestion as to their treatment Text-books in embryology (Keibel and Mall, Prentiss and Arey) show the transition of the mesonephric system and cloaca into the metanephric system, bladder, genitals and rectum The cells on the posterior lateral wall of the Wolffian or general excretory duct have the potentiality in one area of growing into the ureter and pelvis and calyces A little farther down on the Wolffian duct are the cells which develop into the genital tract The ureter starts normally from the general excretory duct as a little bud which protrudes upward and backward On the tip of this bud are the cells which develop into the calyces and collecting tubules Should this ureteral bud start lower down on the Wolffian duct in the genital area, its opening would then be not in the bladder, but into some of the genital organs If female, it might open into the urethra or vestibule While many accounts use the name vagina as place of ureteral opening, I find no case actually opening into the vagina—i e., between the hymen and the uterus This is what one would expect as embryologically the female sex organs develop from the Mullerian ducts and not from the Wolffian ducts If male, it might open into the seminal vesicle, prostate, ejaculatory duct, or urethra

## URETERAL OPENING CAUSING URINARY INCONTINENCE

*Supernumerary Ureters and Kidneys*—Seventy-eight of the cases report that the extravesimal openings were from supernumerary ureters leading to supernumerary kidneys (See diagram 1) Twenty-five of the cases were reported as openings from single kidneys, but in view of the fact that it is very easy to overlook a ureteral opening clinically, it is evident that only those cases reported as verified by surgical exploration of the renal region or at autopsy, or by pyelograms should be credited Only eight of these twenty-five cases were verified—this leaves seventeen cases unverified Doubtless many of these were cases of supernumerary ureters Therefore it may be stated that this congenital anomaly is noted as associated with supernumerary ureters and kidneys in 90 per cent of the cases reported

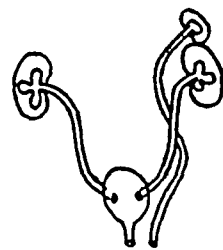


DIAGRAM 1

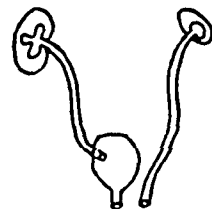


DIAGRAM 2

*Multiple Extravesical Ureteral Openings*—Seven of the 103 cases were reported as having two extravesimal ureteral openings Two cases were bilateral single ureters Both infants and autopsy findings—one described as having no bladder (which seems to me to be embryologically improbable) (See diagram 3)

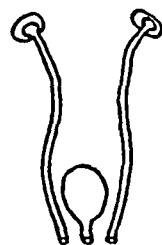


DIAGRAM 3

Two cases were where both ureters from a double kidney on one side opened extravasically (See diagram 4)

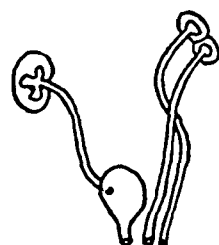


DIAGRAM 4

Three cases were where there was bilateral duplication, and the ureter leading to the upper kidney on each side opened extravasically (See diagram 5)

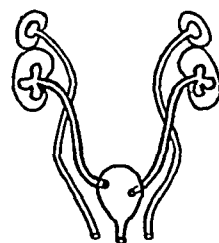


DIAGRAM 5

Instead of there being only one ureteral bud, there may be two ureteral buds—one placed above the other as shown in diagram 6, the lower bud always ending in a renal structure higher than the upper bud. These two ureteral openings may both be so close to the normal position that they open into the bladder, or they may both be so low down on the Wolffian duct that they open into the urethra or genital tract outside of the bladder, or the upper one may open as normally into the bladder, and the lower one may open so low down that it empties into some part of the urethra or genital tract.

From the report of the clinical cases I find that none of these ureters opening extravasically have normal kidney structures, but end in a primitive pelvis with a primitive nephrogenic cap. Therefore, it would appear that when the ureteral bud starts so low down on the Wolffian duct that its opening is extravasical, then it carries on its tip no cells with the potentiality of developing into multiple calyces and the collecting tubules of the medulla, or of stimulating the nephrogenic cap out of its primitive character to develop

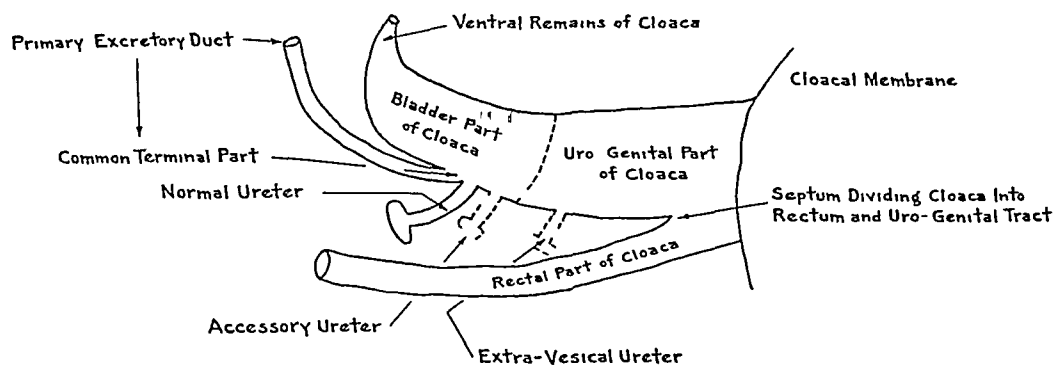


Diagram 6

into a normal cortex. At least, where the renal pelvis remains primitive then the nephrogenic cap remains primitive. Of course this is found also at times when the ureter opens into the bladder, or with cleft ureters, but with ureters opening extravasically it is found in 98 per cent of the cases.

*Diagnosis*—The diagnosis of this condition can and should be made from the history alone. It is seen clinically in females 98 per cent of the time. The history is practically the same in all the reported cases. The woman has been wet ever since she can remember, so that she always had to wear a pad. Otherwise the urinary history is perfectly normal. The patient has to void regularly as does any normal woman. There may be additional symptoms, such as pain in the back, due to hydro-ureters secondary to the strictured outlet, but only rarely is that a prominent feature of the history. This history of being wet since infancy, yet with an otherwise normal urination should make one very suspicious of an extravasical ureteral opening.

The local examination, however, will be disappointing because it is almost impossible to see the tiny opening. The drop of urine appears as

## URETERAL OPENING CAUSING URINARY INCONTINENCE

if it were by magic I would advise anyone to inject intravenously indigo-carmine before looking for the opening This may give the urine a faintly blue tinge When found one will not be able to pass a catheter more than a few centimetres, for it will coil up in the dilated ureter behind the bladder, or the opening may be so small that it admits no catheter However, one can usually show it graphically by the injection of some shadowgraph fluid—preferably skiodan This will show a somewhat tortuous ureter running to the upper pole of a double kidney This ureter will end in a club-shaped primitive pelvis with no calyces, or only the primary ones typical of the rudimentary kidney The lower end of the ureter has a tendency to be dilated secondary to the obstruction of the small opening in the vestibule Practically all of these obstructed cases with hydro-ureters show chronic infection

*Function*—As one would expect, the function of these supernumerary rudimentary kidneys with the ectopic opening into the vestibule is always very poor In fact the excretion of dye is so poor that one can get only the slightest discoloration of the fluid which comes from these ureters after intravenous injection of indigo-carmine However, they can excrete water enough to keep one wet or to form dilated ureters or pelves in case the ureteral opening is too small

It is a fascinating speculation as to what is necessary to stimulate the nephrogenic cells of the cap to develop into a normal renal cortex Or what is necessary in the ureteral bud to make it develop into a normal pelvis with multiple calyces and tubules I have examined many rudimentary kidneys and have never seen a normally developed cortex where the pelvis and calyces were rudimentary Once I have seen a rudimentary cortex where the pelvis and calyces were normally developed Therefore, one can say that a normal pelvis and calyces may develop without the stimulation of a normally developing renal cortex Further one may say that whatever stimulating interaction there may be between these two structures to make each develop normally, the anlage for this potentiality seems not to be present in ureteral buds which have their origin from that part of the Wolffian body which develops into the genital organs or urethra of the male, or that develops into the urethra or vestibule of the female

Embryologically there is no reason to expect that the ureter can ever open into the vagina, uterus or tubes, and no clinical case has been reported in which such an opening has existed, although many have used the term vagina when they meant vestibule This may be predicated from the fact that the female genital tract above the hymen develops entirely from the Mullerian ducts Note especially Gaertner's ducts which are the embryonic remains of the old mesonephric system

Spitzer and Wallin in 1928 (ANNALS OF SURGERY, vol lxxxviii) reported a beautiful case of bilateral supernumerary extravesical ureters, and were evidently very much interested as to whether these supernumerary extravesical ureteral openings led to true ureters and true kidneys, or whether



they were remnants of Gaertner's ducts, and they ended their conclusion with the statement that they wished to emphasize "That cases similar to the

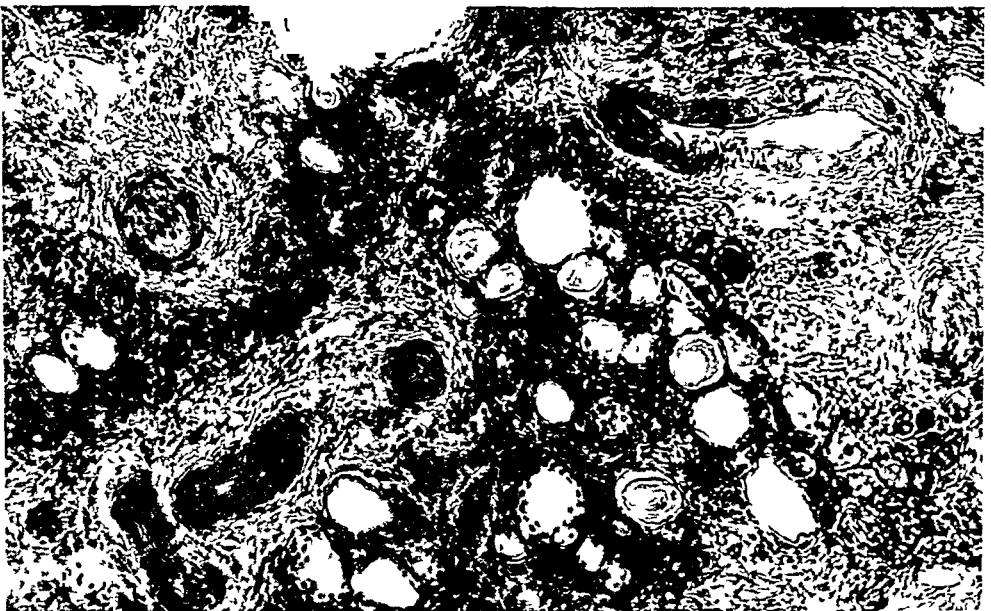


FIG 3 Microphotographs of renal cortex of this case showing definite mesonephric type of renal tubules (A) Upper kidney (B) Lower kidney The lower kidney shows marked fibrosis

one we have described are strongly suggestive of persistent embryonic structures"—meaning "Gaertner's canal" or the "persistent remains of the mesonephric or Wolffian duct" Their bilateral ureteropyelogram showed the extravasical ureters leading to the normal metanephric lumbar location

## URETERAL OPENING CAUSING URINARY INCONTINENCE

If Spitzer and Wallin's speculation were correct, that is if these extravascular structures are not true ureters, but remnants of the old mesonephric duct or canal of Gaertner, one would expect this tube to lead to the embryonic mesonephric tubules in the region of the paroophoron near the ovary. In no case has this been true. In each case the ureter has led to a renal structure associated with the metanephric system, and never to the mesonephric system.

Microphotographs of transverse sections of the ureters, and of the renal cortices of my case (Fig 3) are conclusive evidence that these structures belong to the metanephric system. This case is peculiarly fortunate because the lower kidney drained into the bladder and the upper kidney into

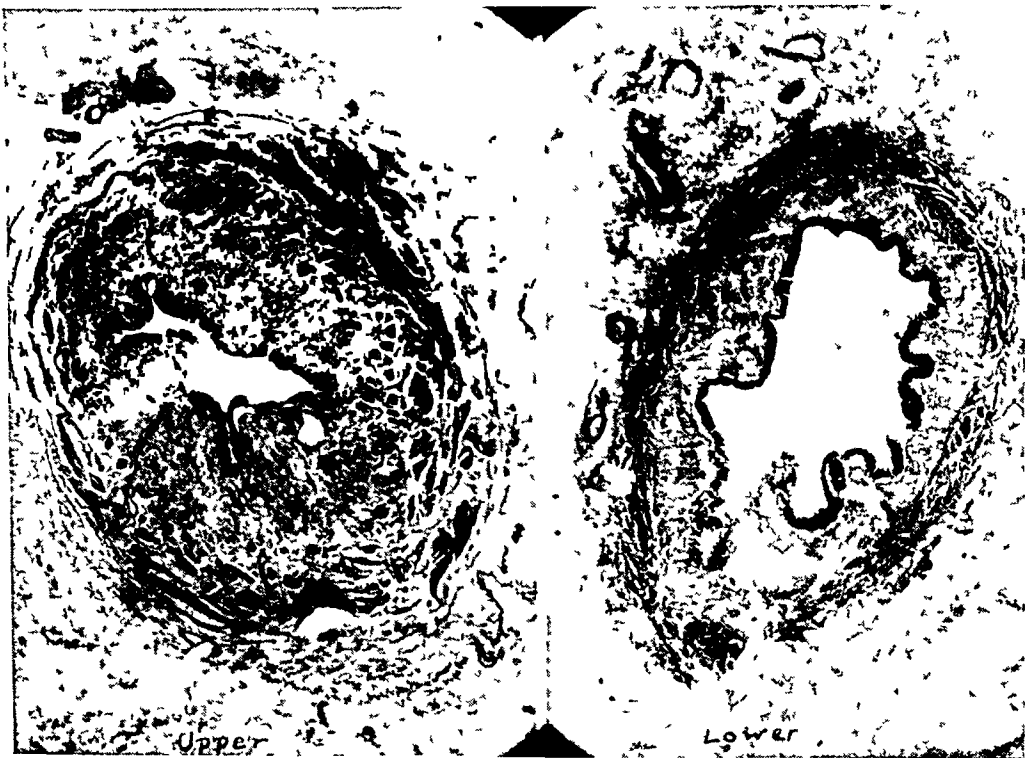


FIG 4—Microphotograph of a cross section of the ureters showing normal metanephric ureteral structure of epithelial and muscle layers, thus differentiating it from the mesonephric duct of Gaertner.

the vestibule. Both kidneys are rudimentary in type, and a study of the photograph shows that the upper kidney had a better cortex than the lower kidney, and is what one would expect to find in rudimentary developed nephrogenic tissue. The ureters show the same type of wall with a definite smooth muscle coat.

Without doubt I think we may concede that these structures are not remnants of Gaertner's duct, but ordinary metanephric structures which have remained rudimentary in form. Although the extravascular ureteral bud may grow into the nephrogenic cellular body and acquire a true nephrogenic cap, they do not have the potentiality to develop into a normal pelvis and calyces or to stimulate its nephrogenic cap into a normal cortex. Therefore, while a ureter opening normally may lead up to a rudimentary form of kidney, a supernumerary extravascular ureter always leads to a rudimentary

form of kidney, and, if not a supernumerary ureter, in the cases reported so far, it leads to either a horse-shoe kidney or rudimentary kidney

*Treatment*—In view of the above analysis, the treatment of this condition is either nephrectomy or resection of the supernumerary, rudimentary kidney. Any surgery aimed at preserving this kidney is unjustified. Ligation of the ureters as reported in several cases is entirely too dangerous a procedure because the pelvis of these kidneys is always infected.

*Conclusion*—(1) A new case with extravescical ureteral opening is reported

(2) An analysis of the preceding cases is made, which shows that

(A) Ninety-eight per cent of the clinical cases are found to be in the female, and ninety per cent of these are associated with supernumerary ureters

(B) The supernumerary ureter with an extravescical opening always leads to a sac-like pelvis which never divides into more than the primary calyces, and drains a rudimentary renal cortex of very slight functional capacity

(C) This rudimentary supernumerary kidney is always situated at the upper pole of the normal kidney structure

(D) That in reporting cases many authors mistake the vestibule for the vagina

(3) From a study of the embryology and the clinical reports there is *no evidence that in the female these extravescical ureteral openings ever open into the tubes, uterus or vagina*—these structures being derived from the Mullerian ducts and not from the mesonephric or Wolffian ducts

(4) Spitzer and Wallin's suggestion that these extravescical supernumerary ureteral structures in the female are remnants of Gaertner's ducts, and that the renal structures that they drain are mesonephric remnants and not rudimentary metanephric cells, cannot be maintained because

(A) These ureters never lead to the region of the paroophoron, but to the normal metanephric region

(B) Because of the microscopical structure of the (1) ureter, and (2) of the renal cortex

(5) The speculation is indulged in as to why the nephrogenic cap to these supernumerary extravescical ureters never develops beyond the rudimentary stage. It is suggested the lack of the cells in the ureter with the potentiality to develop into calyces and tubules is probably the cause. These cells must have some stimulating element necessary to arouse the nephrogenic cells to develop into a normal cortex

(6) The treatment of these cases is always surgical and should be nephrectomy or heminephrectomy according to the type of case. There is no excuse for ligations, or implantations or anastomosis of ureters

# INFECTED SUPERNUMERARY URETER AND PELVIS OF KIDNEY, HEMI-NEPHRECTOMY

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THE comparative frequency of developmental anomalies of the urinary tract, recognized at first only at autopsy as interesting embryological diversities, and at a later period discovered accidentally during the course of abdominal operations, has become known only since the general adoption of modern methods of urological investigation, more especially of urography, and their relationship to co-existent lesions of the urinary system established, and appropriate measures taken in certain cases for their relief Braasch<sup>1</sup> has made a complete study of these conditions, and concludes that duplication of ureters is practically always found with double renal pelvis, these latter surrounded by separate or fused kidneys

The diagnosis of a double ureter is most easily made by cystoscopy and the indigo-carmin test A ureter fissure is assumed only when the ureteral catheter introduced to various levels reveals in one instance a normal and in another a pathological urinary finding, or when pyelography points to abnormal kidney relations The symptomatology pointing to a ureter fissure or double ureter may be indefinite In reference to such a condition is the involuntary discharge of urine in spite of the fact that voluntary emptying of the bladder is possible In such cases one must not be satisfied with a diagnosis of "incontinence of urine," but look after its cause In the female, simple inspection of the vulva and of the vagina shows the opening from which fluid escapes in form of drops If the opening is into the urethra then it can be easily determined, in male as well as in female, by endoscopy The case presented in the present communication is somewhat similar to the two cases reported by Kilbane<sup>2</sup> and the one by McClelland<sup>3</sup> which showed a supernumerary ureteral orifice opening externally on the lateral margin of the urethral meatus, showed the ureter fissure immediately below the urethral orifice Both of Kilbane's cases were nephrectomized while McClelland obtained a cure by ligating the aberrant ureter exposed through an abdominal extra-peritoneal approach Extravesical openings of the ureter have been reported into the prostatic urethra, the seminal vesicals, the vas deferens, the vagina and the anterior urethra

CASE—L W, female, aged twenty-one years, consulted Dr L A M Feher November 8, 1931, for constant dribbling which she had had since childhood A sanitary pad which she wore constantly seemed to take care of her condition and it did not in any way interfere with her routine daily work or hinder her from attending social functions She was now engaged to be married and decided for the first time to consult a physician

to find out the cause of her trouble and have it corrected. She had never had any serious illness and had never been operated upon. The physical examination (Fig 1) was negative with exception that on vaginal examination a small slit-like opening was seen just below the normal urethral orifice, from which cloudy drops of fluid were exuding. This orifice was probed and catheterized and the fluid obtained sent to the laboratory for examination. A cystoscopical examination was then made and this revealed a normal bladder and double ureteral orifices on the right side of the trigone, one just below the other, from which urine was emitting. After careful inspection of the left side only one orifice could be found. While the cystoscope was still in the bladder the sinus orifice was probed but the point of the probe could not be seen entering the interior of the bladder. The patient then entered the hospital for X-ray study. The sinus orifice was

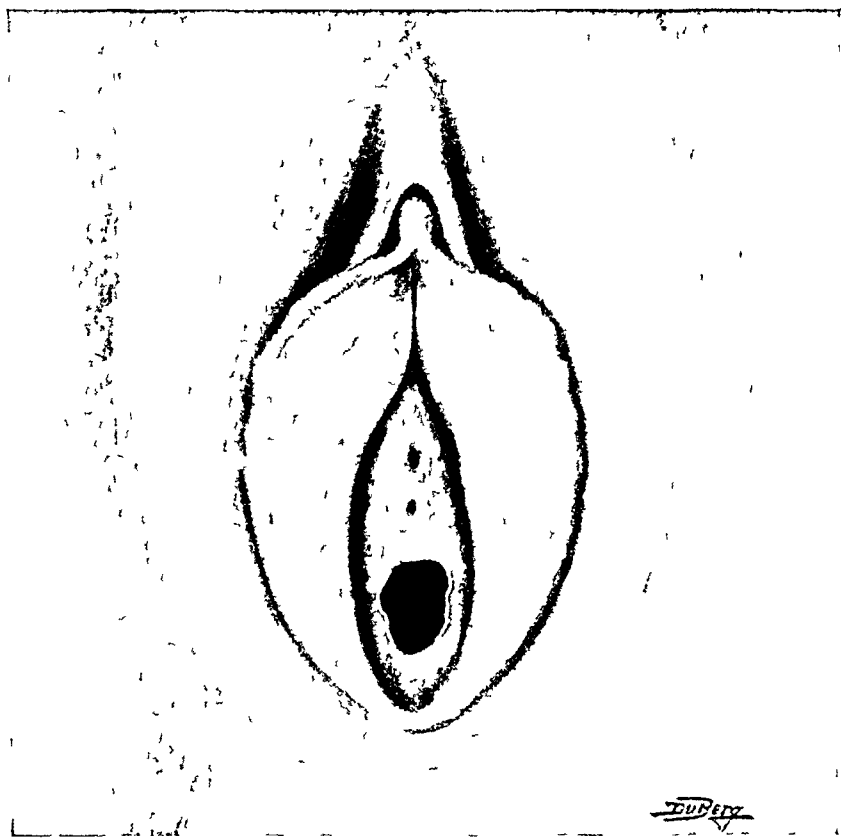


FIG 1—Aberrant ureteral opening below the urethral orifice

then injected with twenty-five cubic centimetres of lipiodol, this amount being considered to be sufficient to fill the sinus tract and an X-ray was taken which revealed only a blind, tortuous sinus (Figs 2 and 3). This procedure was followed with an intravenous injection of skiodan with the hope that the contrasting substance would fill the upper portion of the sinus tract. The X-ray confirmed the presence of a double ureter on the right side but on the left side no definite conclusion could be drawn as the skiodan shadow of the ureter was indistinct. Doctor Feher thought perhaps he was dealing with a tuberculous sinus or an abnormal development of the left ureter. As they were unable to arrive at a definite diagnosis, the patient was again advised to return to the hospital for further study.

*Laboratory Report*—The fluid obtained from the sinus contained clumps of pus, epithelial cells, a few blood-cells, the culture was negative for tuberculosis and established the specimen as urine. Blood Wassermann was negative. Blood chemistry urea, 14.5, sugar, 90, creatinine, 1.3 milligram.

SUPERNUMERARY URETER

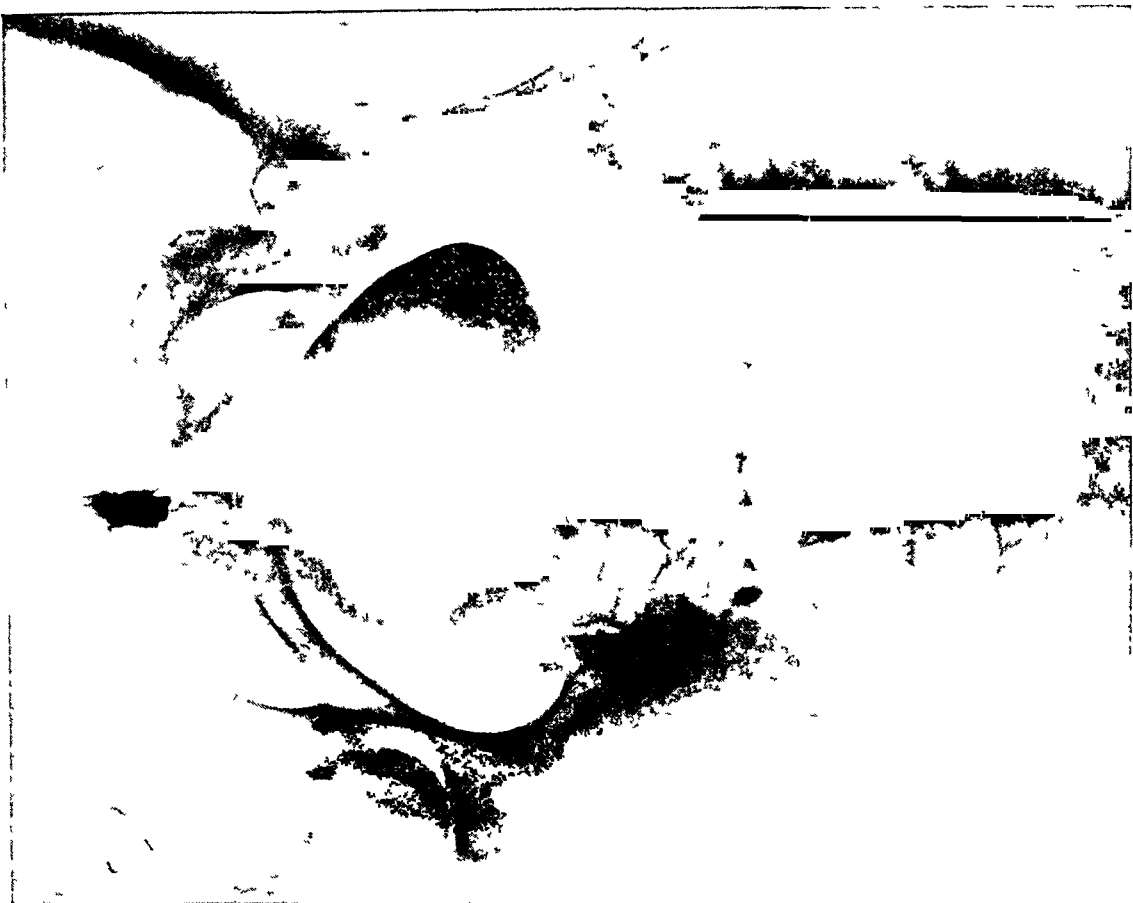


Fig 2—Fissure opening injected with 'lipiodol' terminating in a blind sinus tract Intravenous urogram showing a normal pyelogram of the lower half of the left kidney and a double pelvis and ureter of the right kidney

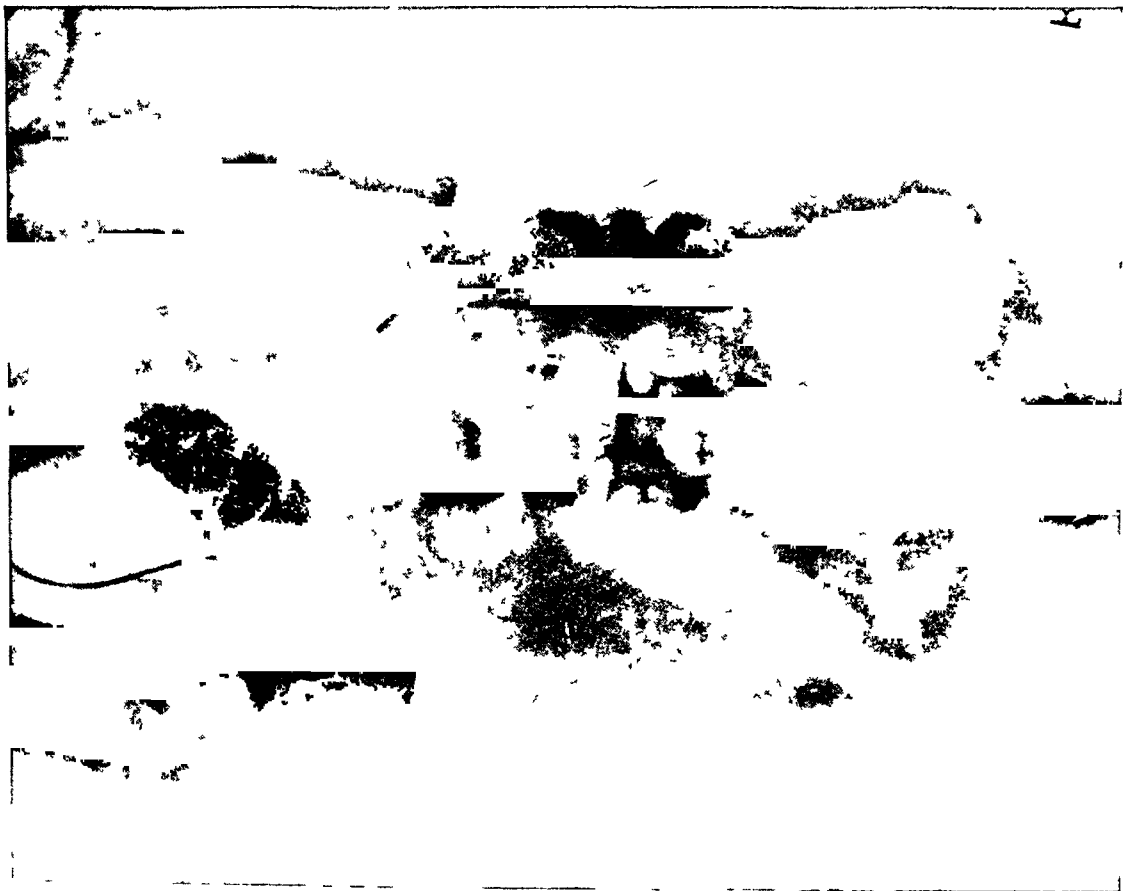


Fig 3—Retrograde pyelogram of the right kidney showing a double pelvis and ureter with blunting of one of the upper calyces

*Cystoscopic Examination*—November 18, 1931, a cystoscopy was again performed and similar findings were again found as on the previous examination. All three ureteral orifices were then catheterized and no obstruction encountered in any of them. The urine obtained from these openings were reported as normal. Good dye concentration was obtained from all three, but more attention was given to the left ureter, into which seven cubic centimetres of sodium iodide were injected and a pyelogram taken. An opaque catheter was then inserted into the sinus and ninety cubic centimetres of sodium iodide were injected before the patient was conscious of any discomfort. Following this,



FIG 4—A composite picture of the kidneys pelvis and ureters taken from the intravenous and retrograde pyelograms showing the supernumerary ureter opening just below the normal urethra and ending in a hydronephrotic sack.

another X-ray was taken. Interpretation of these plates was made by the roentgenologist, Dr. William Klein, as follows:

*Rontgenological Examination* of the genito-urinary tract reveals after the injection of the sinus tract with contrast dye evidence of a supernumerary kidney pelvis on the left side as well as a supernumerary ureter. The upper end of this tract opens into the upper portion of the kidney, at which point it is considerably dilated and at its terminal end reveals what appears to be remnants of minor calyces. This supernumerary ureter runs downward along the vertebral column and is considerably dilated as well as tortuous in its pelvic portion and then is found to open just below the normal urethral

## SUPERNUMERARY URETER

orifice (Fig 4) The dye injected through the opaque catheter shows a normal ureter and pelvis which opens into the lower portion of the kidney, both major and minor calyces appear normal On the right side intravenous skiodan and retrograde pyelography reveal a double pelvis, with double ureters running parallel to one another, emptying normally in the urinary bladder All the major and minor calyces are normal with the exception that one of the minor calyces of the upper pole of the right kidney shows dilatation with blunting

*Diagnosis*—Supernumerary left kidney pelvis as well as supernumerary ureter (dilated) tortuous and atonic with opening (ectopic) just below the normal urethral orifice

*Operation*—After careful study I decided that implantation of the supernumerary ureter into the bladder was inadvisable because of the infection present in the supernumerary kidney Ligation of the ureter was rejected for the same reason Exploration of the kidney with the hope of finding a condition that would permit a hemi-nephrectomy was determined upon December 1, 1931, under gas and ether anæsthesia, the left kidney was exposed through an eight-inch hockey stick incision The greater part of the kidney was readily separated from the surrounding tissues with the exception of the upper pole, which was firmly adherent The kidney was finally mobilized, the lower two-thirds was smooth, unsegmented, while the upper pole, the site of an infected hydronephrotic sac, was thickened and diseased The ureters were then isolated and freed of their connective-tissue adhesions The ureter opening into the lower part of the kidney appeared normal while the ureter which terminated in the hydronephrotic sac was diseased and dilated to the size of the small intestine The renal vessels were then isolated and found to divide into two branches before entering the kidney, one branch going to the upper pole, the other to the lower The upper branch was doubly ligated and divided The dilated ureter was then divided as far down as possible with a carbolized knife between two chromic transfixion ligatures It was impossible to remove the entire ureter at this stage and I felt, if necessary, at a future date to do a secondary operation to remove the remaining portion of the diseased ureter The kidney capsule was then slit along the superior border, around the upper pole and then reflected back anteriorly and posteriorly upon the normal portion of the kidney beyond the line of demarcation which now formed The upper portion of the kidney was amputated just along the line of demarcation, taking a good wedge of healthy kidney with it The cut surface of the kidney revealed that a part of the terminal end of one of the calyces had been removed The edges of this calyx were approximated with a continuous suture, using a fine circumcision needle and gut The oozing was controlled by four interrupted mattress sutures which dipped deeply into the renal tissue to close the rent Small pieces of fat were inserted under the suture to prevent cutting through the capsule The reflected capsule was then sutured over the raw area with a continuous running catgut A cigarette drain was placed along the sutured pole and the wound closed in layers

*Post-operative Course*—The post-operative course was uneventful, the temperature never rose above 100° F the first three days and thereafter remained normal At no time was there any urinary leakage The cigarette drain was removed on the fifth day and the wound healed by primary union The urinary dribbling stopped entirely after the fourth day The patient left the hospital on the twenty-first day in excellent condition Fig 4

Pathological examination of the portion of kidney and ureter demonstrated an infected hydronephrosis with an accessory ureter, ureteritis cystica Cystoscopy on January 24, 1932, six weeks after operation, revealed a normal bladder, all three orifices functioning normally Indigo-carmin excreted from the hemi-nephrectomized kidney was four plus in three minutes A pyelogram was taken of the remaining half kidney, five cubic centimetres of sodium iodide were injected through a catheter but the calyces were not filled to capacity for fear of causing some damage so soon after the operation



CONCLUSIONS

(1) Thorough urological examination necessary for "Incontinence of Urine"

(2) Pathological changes are frequent in this type of anomaly

(3) Resection of double kidney is practical provided the disease is definitely confined

(4) Hemi-nephrectomy in a case of an extra-vesical accessory ureter gives good results and the urinary dribbling is eliminated, together with the somatic and psychic symptoms

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## POST-OPERATIVE URINARY RETENTION \*

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POST-OPERATIVE retention is that condition in which the patient after an operation finds it impossible to urinate in spite of normal kidney function, a full bladder and the absence of organic obstruction. The time limit beyond which retention after operation must be considered pathological depends on several factors, *i.e.*, the time and amount of the last pre-operative evacuation of the bladder, the duration of the operation, and the fluid intake of the patient. Taking these facts into consideration, we usually are not concerned until eighteen to twenty-four hours after operation. Some writers contend that retention is present as soon as the patient complains of discomfort and inability to void. The majority diagnose retention when palpation and percussion of the bladder show it to be three fingers above the pelvic brim.

In the literature we find the incidence of post-operative retention reported as ranging from 10 to 55 per cent. An analysis of our own series shows an incidence of 12.5 per cent (eighty-one cases) in 644 operations performed under general anaesthesia. Of the eighty-one cases of retention, thirty-seven or 47 per cent required catheterization and of these thirty-seven cases, nine or 23 per cent developed cystitis. One case developed epididymitis. Of the thirty-seven cases requiring catheterization, this had to be repeated in fifteen or 39 per cent.

The series was next analyzed as to incidence of age, sex, type of patient, type of anaesthesia, type of post-operative medication and treatment, and type of operation.

(1) *Incidence As to Age*—Retention occurred in patients ranging from fourteen to seventy years of age. It was most common in young adults but never occurred before puberty.

(2) *Incidence As to Sex*—In this series of eighty-one cases, retention occurred in forty-seven females and thirty-four males. These figures confirm the prevalent findings of a slightly higher incidence in women. A few more men than women were operated in this series of 644 cases.

(3) *Incidence As to Type of Patient*—Of the eighty-one cases of retention thirty-seven were private patients and forty-four ward patients. Considering the much larger proportion of ward patients operated upon we have here a definitely higher incidence of retention in private patients. This finding points very significantly toward the type of patient in which we usually are confronted with this problem. These patients can be spotted almost before operation. They are hypersensitive, apprehensive, psychoneurotic individuals.

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\* Read before the Philadelphia Academy of Surgery, November 7, 1932.

with but little self control The least pain or discomfort arouses a marked psychic reaction They are afraid to suffer the pain of urination When examined the morning after operation these patients will speak to you in a low voice, hesitating even to take a deep breath for fear of pain or rupturing their wound They have a very low threshold for pain

(4) *Incidence As to Type of Anæsthesia* —

TABLE I			
Anæsthesia	Cases	Retention	Per Cent
Ether	232	29	12 5
Gas-ether	78	21	27 0
Gas	206	10	4 8
Spinal	124	24	19 3
Local	71	0	0 0

Reviewing the above figures one is struck by the high incidence of retention after gas-ether anæsthesia This might be partially explained by the type of operation for which this anæsthesia is commonly used, that is, in appendicectomies and other lower abdominal operations, but I believe that the addition of ether to the gas carries most of the blame The depth of anæsthesia has much to do with post-operative retention The longer and deeper the anæsthesia the higher the incidence of retention Ether, for this reason, is probably responsible for most cases of retention A fact which is brought out clearly by the above figures is that a considerable number of spinal anæsthesias are followed by retention, showing that causes other than ether may be responsible for the production of retention In spinal anæsthesia we probably have a direct interruption of the bladder reflex

(5) *Incidence of Proctoclysis in Retention* — Of the eighty-one cases, sixty-three or 77 per cent received proctoclysis The eighteen cases which did not receive proctoclysis are as follows

Hernia	5
Cancer of rectum	2
Colostomy	2
Hæmorrhoids	2
Pilonidal cyst	2
Appendicitis	1
Partial gastrectomy	2
Epididymitis	1
D & C	1

I believe these data are quite significant with regard to the etiology of retention Proctoclysis is not always the sole cause of retention, but it is often responsible for it, and retention can be relieved by discontinuing the proctoclysis With the exception of two gastrectomies and one appendectomy the remainder of the cases which did not receive proctoclysis had operations which either involved the rectum directly or involved the genito-urinary nerves, as in hernia It is held by Kohler that the sphincter ano and the sphincter vesicæ cannot be opened simultaneously Some of our patients

## POST-OPERATIVE URINARY RETENTION

voided immediately after the proctoclysis tube was removed, and some, on the other hand developed retention three to six days post-operatively after the use of the rectal tube to relieve distention. In one case in which repeated bouginage for rectal stricture was done, retention developed each time the large bougie was left in the rectum.

### (6) *Incidence of Type of Operation —*

TABLE II

Type of Operation	Cases	Retention	Per Cent
Appendectomy	131	26	19.8
Gall-bladder	51	8	15.8
Hernia	70	11	15.7
Hæmorrhoid and rectal	77	11	14.3
Gastric	32	12	37.5
Extremities	109	0	0.0
Breast	38	3	7.8
Chest	29	2	6.5
Goitre	25	1	4.0
Major abdominal	55	4	12.7
Hysterectomy	10	2	20.0
Head and neck	94	2	2.1

Thus we find an incidence of post-operative retention after abdominal operations of 18.6 per cent, after rectal and inguinal operations, of 14.9 per cent, and after operations on the rest of the body, of 2.7 per cent. The incidence after gastric operations seems highest probably due to the fact that they require the longest and deepest anæsthesia, always require ether and produce the most profound shock. This type of operation prevents the patient from using his diaphragm and abdominal muscles for exerting pressure on the bladder. Then too the type of patient who suffers from ulcer is usually high strung and nervous with a slightly imbalanced vegetative nervous system. Operations involving the pelvic organs show the next greatest frequency of post-operative retention. They actually damage part of the nerve supply to the bladder and probably directly interfere with the reflex arc of micturition.

Retention is surprisingly common after appendectomies. One might explain this by the nearness of the bladder to the operative field, but it is my belief that this and the injury to the inguinal nerves as in hernia only partially explain this high incidence. Another explanation can be found in the fact that we give proctoclysis routinely in all appendectomy cases. It has also been noted that retention usually occurred in those patients who seemed to have acute symptoms without much pathology in the appendix.

These figures demonstrate that opening the abdomen, and nearness of the field of operation to the bladder and rectum have a definite influence in retention. Operations on the head, neck and chest, and extremities were followed by retention in only 2.7 per cent.

Experimentally we studied the condition of the bladder in retention by means of the cystometer which has been constructed according to Muchat's

and Johnston's modification of Rose's cystometer. This instrument is best adapted to determine intracystic pressure, because it permits of bladder-pressure readings at different degrees of filling. We plotted curves of intracystic pressure in twenty humans and determined intracystic pressure approximately 300 times in dogs under many different conditions.

At first I will show a normal intracystic pressure curve (Fig 1). The bottom curve represents the tonus of the bladder muscle and this pressure averages about 10 millimetres of mercury. The bladder capacity averages around 500 cubic centimetres but some normal bladders can hold as much as 1,100 cubic centimetres without discomfort. The next higher curve indicates

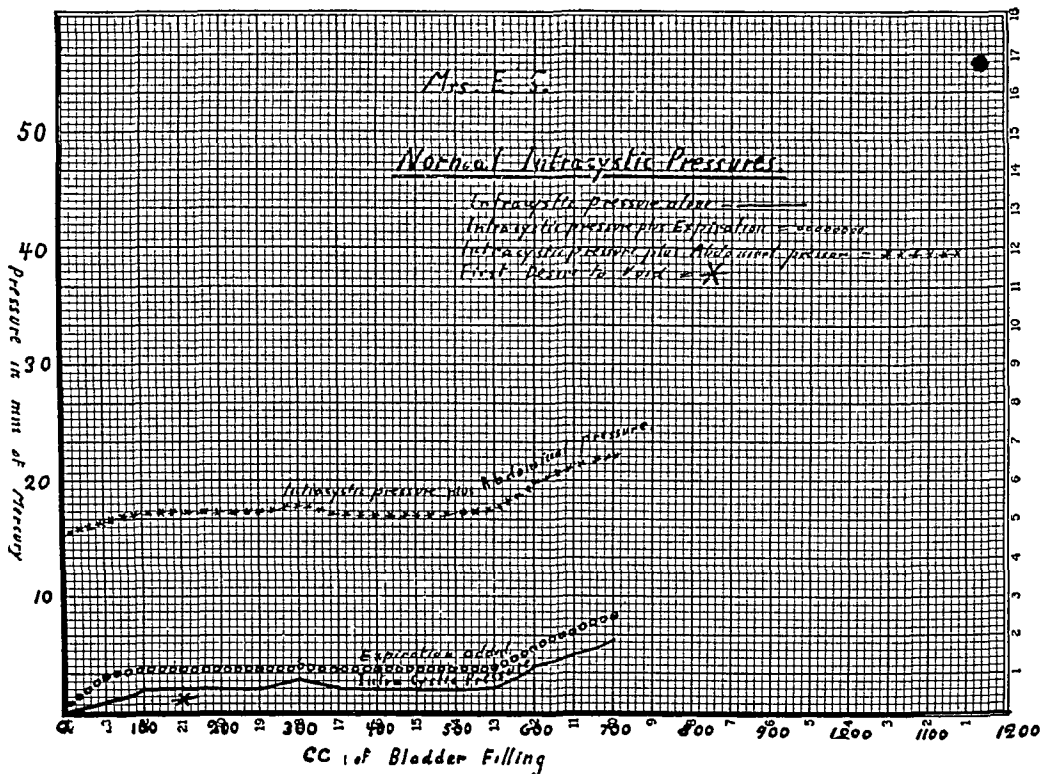


FIG 1—Mrs E S, thirty eight. Operation for umbilical hernia under spinal anaesthesia. Pressures were taken thirteen days after operation when normal bladder function was established. She voided 450 cubic centimetres before the catheter was introduced.

the additional pressure which is obtained on deep breathing, the pressure rising on expiration.

The uppermost curve indicates intracystic pressure reinforced by abdominal pressure. This pressure is obtained by the patient's voluntary attempt to void and is usually about 20 to 30 millimetres of mercury higher than the bladder pressure alone. The effect of abdominal pressure upon intracystic pressure is another important factor in the production of retention. In plotting intracystic pressure curves we always carefully note the degree of filling of the bladder at which the patient has the first desire to void. This usually occurs at about 150 to 200 cubic centimetres of filling.

If we now consider the chart of a patient with retention, we see a low curve together with an increased capacity of the bladder, demonstrating

## POST-OPERATIVE URINARY RETENTION

decreased tone of the bladder muscle (Fig 2) There is no rise in pressure on the attempt to void Vigorous efforts of the patient to bear down upon the bladder are without success The first desire to void is either entirely absent or it does not develop until the bladder is filled up to 500 cubic centimetres, revealing a disturbed sensibility of the bladder

With our own clinical and experimental data in mind, we will now briefly review the physiology of the bladder The function of the bladder is to retain urine passively and to expel it under voluntary control This makes the bladder a vegetative organ with a partially voluntary control, and in this lies the complexity of the problem of micturition The bladder for the same

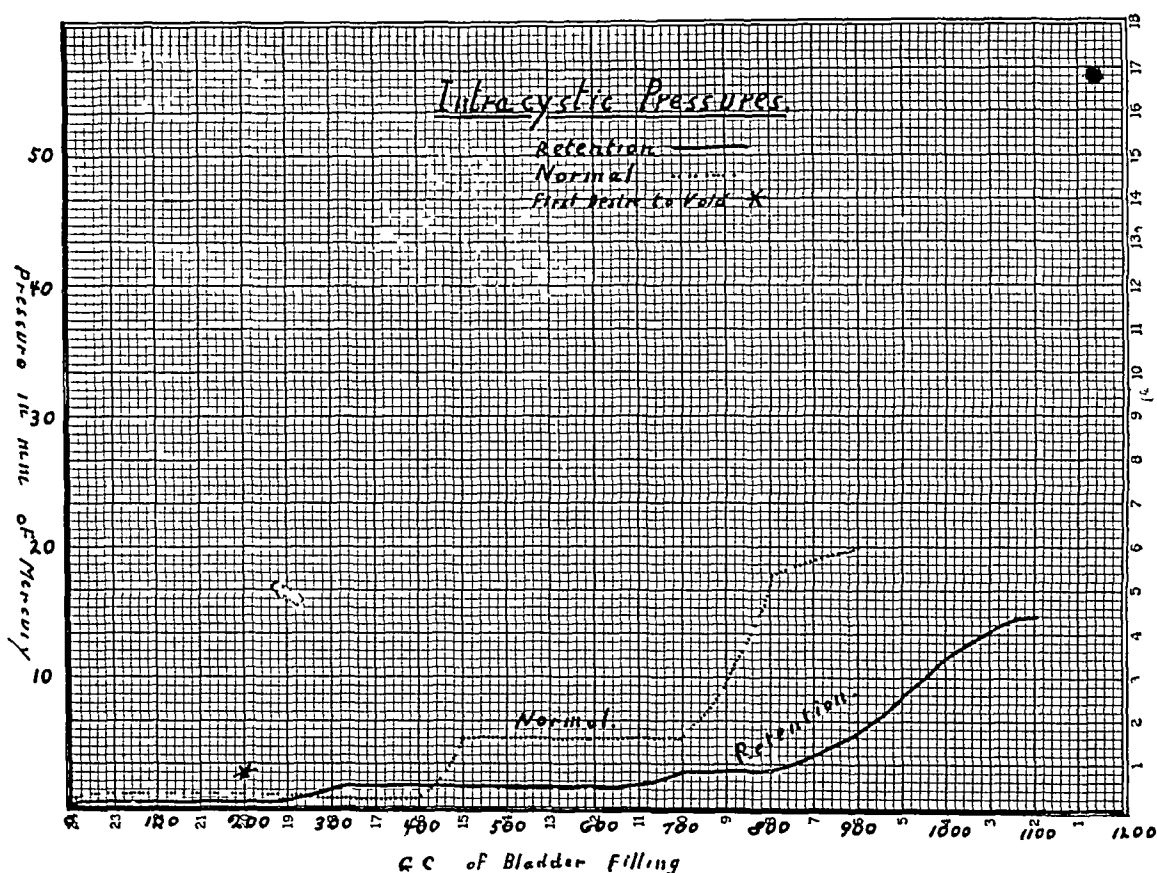


FIG 2—Mr. M., forty-seven. Retention developed after radical excision of carcinoma of rectum. Spinal anesthesia. The normal bladder pressure curve was taken eighteen days after the pressure curve with retention.

reason is the organ in the body most often affected by neurosis and very frequently pictures a person's vasomotor and vegetative make-up. Take the person who cannot void in the presence of another from the traditional sense of shame. Many people cannot void in the recumbent posture, because they associate this with bed-wetting, for which they have suffered much discomfort in early infancy. Micturition is autogenetically very closely related to the sexual act. The same nerve which causes micturition will cause ejaculation in man. The pelvic nerve which causes erection also causes emptying of the bladder. In children the act of micturition produces a sensation similar to the sexual act and this condition may persist in later life as a neurosis. In grown-ups we have a synergy between automatic and voluntary micturition.

Anything which disturbs this synergy will produce a bladder dysfunction be it enuresis, retention, or an irritable bladder. The bladder thus may easily become a highly neurotic organ because it is supplied by such a neuropsychical mixture of automatic, autonomic, and voluntary nerves and also because it is related mentally and somatically to the sexual sphere.

There are three sets of nerves to the bladder (Fig 3). The sacral autonomic nerve supply through the pelvic nerve causes contraction of the detrusor and relaxation of the internal sphincter, while the sympathetic through the hypogastric causes relaxation of the detrusor and contraction of the internal sphincter. The parasympathetic nerve is the nerve of bladder emptying and the sympathetic the nerve of bladder filling. The rôle played

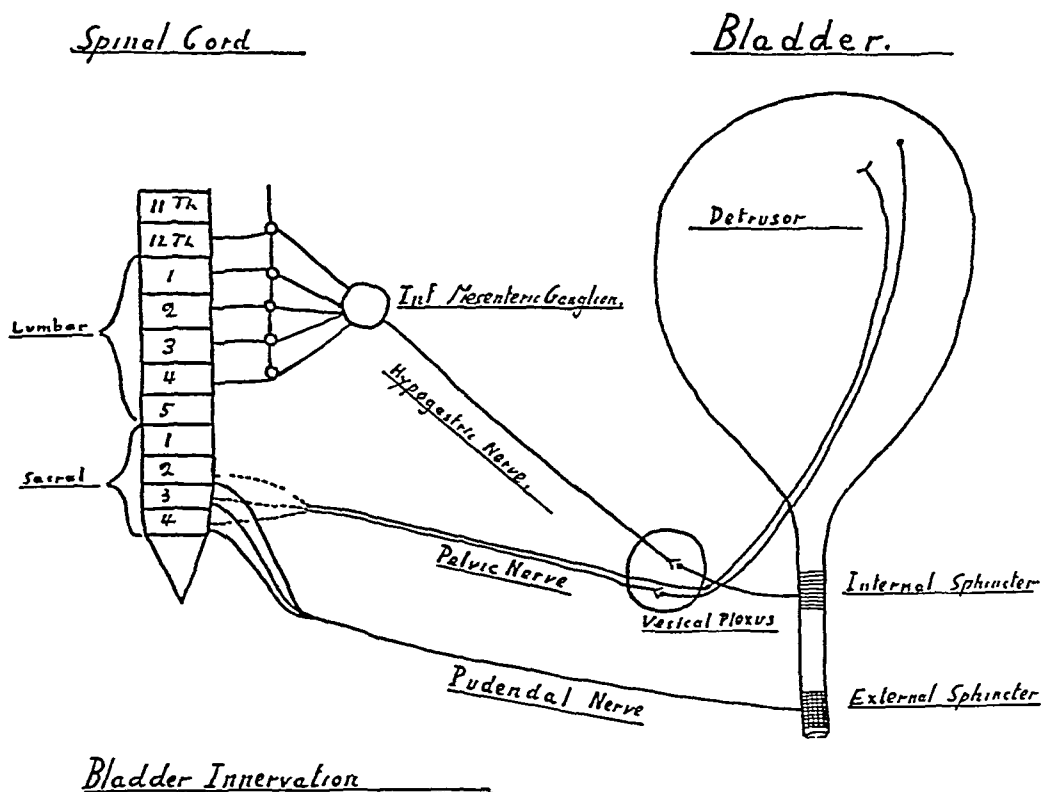


FIG 3—Diagrammatic representation of the bladder innervation

by the pudic nerve, the somatic nerve, in micturition is interpreted variously by different authors. Most of them agree that it innervates the external sphincter, and thus by voluntary control can prevent leakage of urine. They also agree that it carries sensory fibres and thus acts as the sensory nerve to the bladder. Besides a cortical centre for bladder control there is probably also a centre in the mid-brain, for changes of mood have a definite influence upon bladder function. Mood is as important for voiding as for sex function.

We can thus easily see why it is so difficult or almost impossible to explain the cause of post-operative retention by any single factor and why there are so many different theories. Most authors do agree, however, that an over-balance of the sympathetic nervous system constitutes at least one big factor

Considering the cross-innervation of the bladder, this seems quite plausible. The proof of this theory lies in the success obtained in treatment of the condition by several European authors from the use of pilocarpine.

After careful analysis of the clinical and experimental material, it would be erroneous, however, to attribute all retention to this one cause for there can be no doubt that such factors as anæsthesia, post-operative morphine medication, proctoclysis and the opening of the abdomen also play some part in causing this dysfunction. Of course, anæsthesia, morphine, and proctoclysis might also be linked to the disturbance of the vegetative reflexes either by interruption or by a transient post-anæsthesia acidosis. Morphine, as has been shown by animal experiments, may cause a spasm of the internal sphincter. Proctoclysis by the rectal tube upsets the normal reflex of the sphincter vesicæ. The effect of opening the abdomen upon retention is purely mechanical and has nothing to do with the vegetative nervous system. The incision of the abdominal wall produces in the latter a tendency to splint itself involuntarily, thus incapacitating the so-called "bauchpiesser" which is of such importance in exerting pressure on the bladder. The fear of pain in contracting the abdominal muscles leads us to the last important factor in retention, namely, the psychic element. Sachs believes that the pain connected with contractions of the abdominal muscles and even the fear of such pain leads to faulty innervation and to a spasm of the voluntary or perhaps even of the involuntary sphincter and thus to retention.

Summarizing our own clinical observations with regard to the etiology of retention we can say that it is caused not by any single factor but that it depends upon several and that at different times one factor or another may predominate. The reflex of micturition is disturbed by (1) vegetative imbalance, in which anæsthesia, post-operative medication, or proctoclysis may play a part, (2) mechanical interference with the "bauchpiesser" and (3) by the psychic make-up of the patient.

When we now turn to the treatment of this condition, aware of the complexity of the problem, we are quite prepared to find many obstacles. There have been almost as many treatments as authors reported writing on this subject. In every patient with retention certain classic measures which are known to every nurse and orderly are tried first. These measures, however, often fail, and then we are forced either to catheterize the patient or to try some of the various methods which will be discussed below.

Sachs, who believes in the psychic cause of retention, treats all his patients with psychotherapy and claims good results. Lampert, Henrickson and other Russian, German and French investigators, believing firmly that the cause of retention is a disturbance of the parasympathetic nervous system, treat their cases with pilocarpine.

Those who believe in a diminished sensibility of the bladder mucosa as a cause use intravenous urotropin and cytotropin with apparent success and others who believe in spasm of the internal sphincter as the sole cause of retention relieve this spasm by administration of potassium acetate. Pituitrin,



which increases the power of the bladder muscle, is used by still another group

In reviewing the different methods and their varied results, one is rendered very skeptical as to the possibilities of a specific treatment for this condition. From 300 intracystic pressure readings with the cystometer in dogs and from my treatment of thirty-seven patients with retention, I have obtained the following results

The first chart shows the effect of various drugs upon the dog's bladder (Fig 4). Female dogs were used in all the experiments. The catheter was introduced without anæsthesia and the intracystic pressure curves taken with the dog lying down. The normal curve as represented on this chart shows

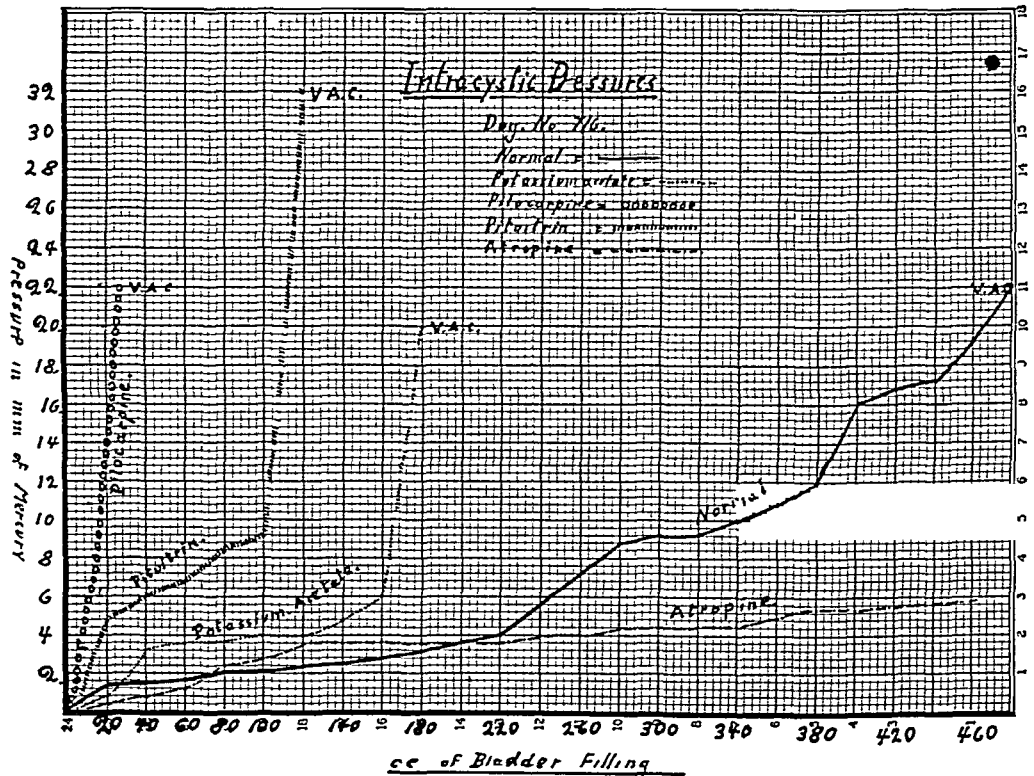


FIG 4—Intracystic pressure curves of a female dog

the bladder capacity of 480 cubic centimetres and a maximum pressure producing micturition around the catheter to be 22 millimetres of mercury. The dog, like the human being when about to urinate, attempts to assume the standing posture, in which the bladder pressure always rises at least another 10 millimetres of mercury. Dogs differ from human subjects, however in that after intracystic pressure exceeds a certain level they always void around the catheter. This point of voiding represents the tonus of both the internal sphincter and of the bladder. In only one human being have I encountered a sphincter which permitted voiding around the catheter, suggesting that if the human bladder functioned like that of the dog there would be no post-operative retention.

Intravenous injection of pilocarpine grain 1/12 will produce a curve as

## POST-OPERATIVE URINARY RETENTION

shown on the chart. A similar curve was obtained by subcutaneous injection of 10 milligrams of acetylcholin. Pituitin when injected subcutaneously also causes increased bladder tonus in dogs. Potassium acetate in a 1:15 dilution if introduced into the dog's stomach will increase the bladder-pressure.

It would be too tiring here to review the many different curves which were obtained by animal experimentation, and I will therefore review briefly the effects of a few drugs upon the human bladder. Pilocarpine given intravenously in doses of  $\frac{1}{8}$  g or more would be the best and most direct way of combating retention. I have tried pilocarpine intravenously and hypodermically in smaller doses in humans and I got only a slight rise in pressure. If the larger doses are used there is considerable abdominal pain, much increase

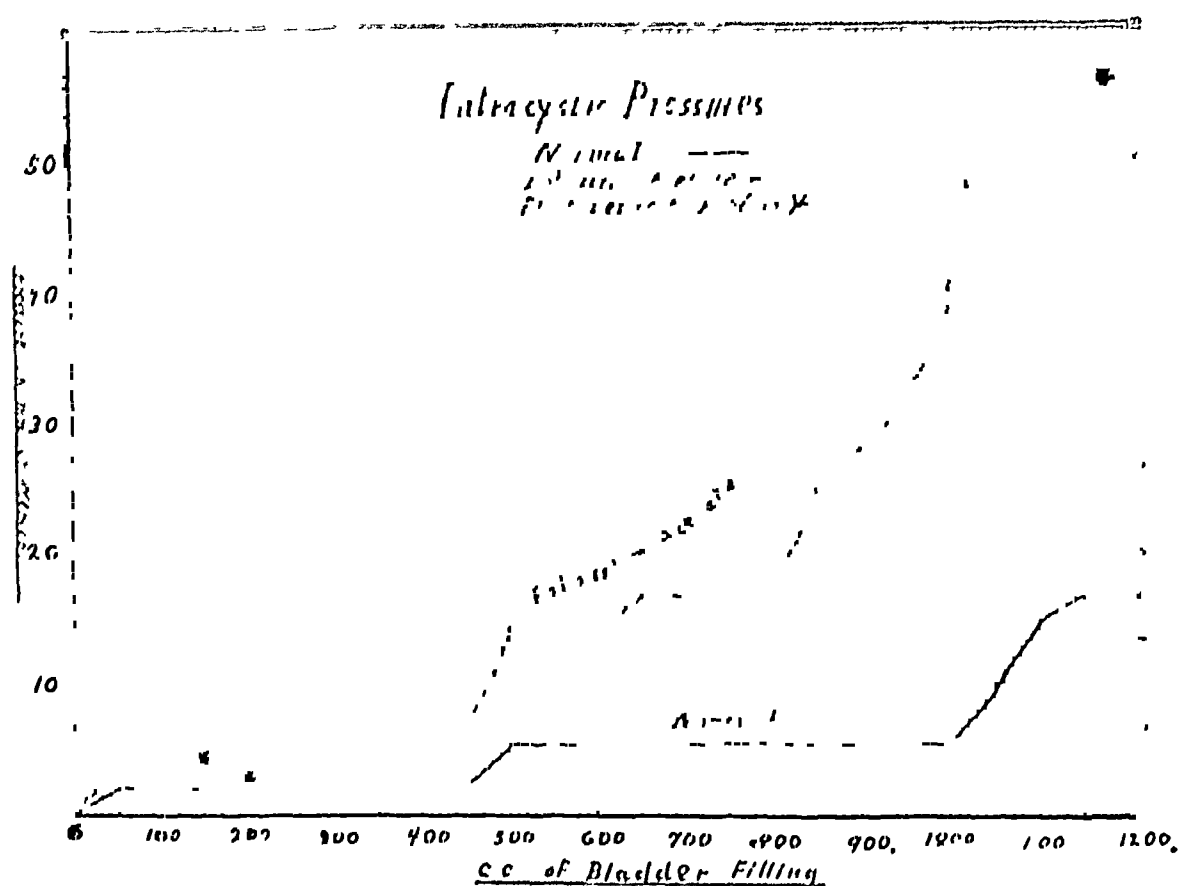


FIG. 5. Mr. G. F., sixty-three. Retention developed after posterior resection of carcinoma of rectum. Potassium acetate ounces ss. every one half hour for eight doses (1:15) was given and then the above intracystic pressure was taken. The normal intracystic pressure curve was taken thirteen days later.

in peristalsis, and profuse perspiration, there is also grave danger of pulmonary edema. I believe the increased peristalsis and the pulmonary edema are sufficient contraindication to prevent its use in most cases. Acetylcholin when used in therapeutic doses has only very slight influence upon the bladder-pressure. Potassium acetate when given in dilution of 1:15 in doses of one-half ounce every half hour caused a definite rise in bladder tonus (Fig. 5.)

My own treatment in the present series has been based upon the theory that involves not one but several factors. Psychological treatment was carried out by talking to the patient and dispelling his fears, and by assuring

him if he could not void a painful catheter might have to be used. Frequently the patient voided after this talk. To correct the sympathetic overbalance and reflex disturbance, the proctoclysis tube or rectal tube should always be removed. Potassium acetate, which is both a parasympathetic stimulant and diuretic, should be given by mouth. The lack of the "bauchpresser" is the most difficult factor to correct, but it can be at least partially supplanted by firm pressure over the lower abdomen. I have proved, by means of the cystometer, that such pressure will increase intracystic pressure about 10 to 20 millimetres of mercury.

My reasons for preferring potassium acetate as an adjuvant to the psychic and mechanical treatment are the following: (1) It is comparatively easy to take, (2) it is absolutely harmless, (3) experiments have shown that it increases the tone of the detrusor muscle of the bladder and it has a definite diuretic action, (4) it is a parasympathetic stimulant.

The typical action of the acetate was as follows. As soon as retention was established, the patient was given one-half ounce of a 1:15 solution of liquor potassii acetatis by mouth every half hour for eight doses. Usually within this time and occasionally as late as one hour after the last dose the patient began to void anywhere from 200 to 700 cubic centimetres and he would continue to void almost every three hours for the next twelve hours.

About one-half of the eighty-one cases of retention were treated in this way, with the following results:

Before this special study was made approximately 90 per cent of all cases of retention were catheterized. During the first half of the period in which this study was conducted about 60 per cent of all patients with retention were catheterized and during the last half of this period, 28 per cent of all retention cases needed the catheter. Potassium acetate was used in thirty-eight of these cases and it was successful in twenty-six or 69 per cent of the cases. These figures prove that much can be done in the treatment of retention but also that the above treatment is by no means ideal.

*Summary*—With regard to etiology we can say that retention is caused not by any single factor but that it depends upon several and that at different times one factor or another may predominate. The reflex of micturition is disturbed by (1) vegetative imbalance, in which anaesthesia, post-operative medication, or proctoclysis may play a part, (2) mechanical interference with the abdominal pressure or "bauchpresser," and (3) by the psychic make-up of the patient.

Treatment was carried out with these three factors in mind. Vegetative imbalance was combated by stopping proctoclysis and giving potassium acetate, the mechanical factor was overcome by pressure over the lower abdomen and by deep inspirations, and finally the psychic derangement was corrected by psychotherapy.

By this treatment the percentage of catheterization was reduced from 90 per cent to 28 per cent.

# POST-OPERATIVE URINARY RETENTION

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# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD DECEMBER 5, 1932

The President, DR JOHN SPEESE, in the Chair  
CALVIN M SMYTH, JR M D , Recorder

### BURN-SCAR CONTRACTURES OF UPPER EXTREMITY

DR ROBERT H IVY and DR LAWRENCE CURTIS presented two patients, showing correction of burn-scar contractures of the upper extremity

CASE I—A girl, aged eleven years, was admitted to the Graduate Hospital September 3, 1931, with severe burn scars of the left arm and axilla, extending over the pectoral and scapular regions. The left wrist and elbow were fixed in flexion and the arm from the shoulder to the elbow was bound to the side of the chest by a continuous band of scar tissue. The skin about the elbow showed desquamation, and was ulcerating in several areas with granulations. The burn had been sustained twenty-one months previously.

From September 4, 1931, to May 27, 1932, a series of operations was performed to correct these deformities. The first operation consisted in freeing the left arm from the side of the chest. The web of tissue joining the two was divided from the shoulder to the elbow, until free movement of the shoulder-joint was obtained. The remaining raw surfaces on the side of the chest and inner aspect of the arm were partly closed by undermining and bringing the edges of the wounds together. A gap high up in the axilla was filled with a full-thickness skin graft from the abdomen. Scarlet red ointment was helpful in healing remaining granulating surfaces. Ultra-violet radiation was also used twice weekly. On readmission to the hospital February 18, 1932, the axilla and arm having completely healed, and the patient being able to raise the arm above the level of the shoulder, attention was directed to the contracture of the elbow. February 19, 1932, a vertical tube of skin and subcutaneous tissue about twelve inches in length was made on the left side of the back (Fig 1). April 1 an area of tissue connected with the lower end of the tube was outlined, partly raised and sutured back in position. April 15 the left elbow was straightened out after wide excision of adherent skin and scar tissue and lengthening of biceps tendon. The lower end of the tube-pedicled flap on the back was raised and carried over to be sutured to the edges of the raw surface on the flexor aspect of the elbow. May 27 the upper end of the tube was detached from the back, the whole tube opened out and sutured to cover the remaining raw surface about the elbow. June 6, 1932, patient was discharged from the hospital, wound nearly healed and with ability to almost fully extend left elbow (Fig 2). Occupational therapy has brought about further improvement. The problem of the wrist and hand remains.

CASE II—A girl, aged nine years, was admitted to the Graduate Hospital in October, 1931, with a band of dense scar tissue on the anterior aspect of the right axilla, resulting from a burn when three and a half years old. The scar restricted movement of the shoulder so that the arm could not be

raised farther than a horizontal position. This was corrected by the Z plastic operation described by McCurdy (McCurdy, S. L. Surg., Gynec., and Obst., vol. xvi, p. 209, 1913), in which it is not necessary to resort to skin grafting. An incision was made along the edge of the scar band (not across it), and from the ends of this line incisions were made at about right angles to it, one being back across the arm and the other on the front of the chest. By undermining, two triangular flaps were formed and transposed. This procedure effectually obliterated the scar band and released the shoulder-joint so that after healing normal movement of the arm was restored.

DR. ROBERT IVY said both of these cases were treated in the acute stages of the burns with the limb extended in the hope of avoiding contracture. In spite of this, a few months after removal of the extension apparatus the contractures occurred.



FIG. 1.—Burn scar at elbow and axilla, tubed pedicle at back.

FIG. 2.—Result of series of plastic operations on the burn scar shown in Fig. 1.

## DI-VINYL ETHER—A NEW ANÆSTHETIC

DRS. I. S. RAVDIN, GEORGE P. MULLER, and, by invitation, DRs. SAMUEL GOLDSCHMIDT, BALDWIN LUCKE and C. G. JOHNSTON presented a preliminary report on the results of a clinical and experimental study of Di-Vinyl ether, a new compound which is capable of producing surgical anæsthesia. The outstanding features of this preparation are the rapid induction, rapid recovery, and singular freedom from unpleasant after-effects. Regarding toxicity it appears to stand between ethyl ether and chloroform. The experimental studies are being carried out in the laboratories of Research Surgery and of Physiology at the University of Pennsylvania and to date have included observations of the effect upon the liver, the concentration in the blood required to maintain anæsthesia and the margin of safety between



anæsthetic and lethal doses The experiments have all been conducted with careful controls

Doctor Muller and Doctor Ravdin have administered or caused to be administered this anæsthetic to eighty-two patients varying in age from one to eighty-three years The type of operation included practically all general surgical conditions except those of the biliary tract which were excluded on account of lack of accurate knowledge of the effect upon the liver

The average time required to induce anæsthesia was forty seconds and most patients were able to answer questions intelligently in a few minutes after the administration was terminated

Further studies are necessary before the investigators are ready to recommend this preparation to the profession, but it would appear to possess some of the features necessary for the long-sought "ideal anæsthetic"

#### REPAIR OF UNUNITED FRACTURES BY LATERAL APPPOSITION AND INTERNAL FIXATION

DR A BRUCE GILL said that this principle is not new, but it may probably be applied with advantage more frequently than is now done

When it is possible to convert an old ununited fracture into an oblique fracture, to secure a lateral apposition, and to fix the fragments securely together by screws union is more certain than by any other method of operation Furthermore, the technique of the operation is easier and simpler than the various types of bone-grafting operations While this method of operation applies particularly to fractures of the tibia, the femur, and the humerus, the same principle of operation with slight variation can be applied in cases of non-union of the bones of the forearm A few years ago on examining his records to determine the end-results of operations for this condition the speaker learned that he had obtained union in only 50 per cent of the cases by the use of intramedullary grafts, inlay grafts and osteoperiosteal grafts About four years ago he began to employ a different method and since then has had no failures The radius or the ulna is exposed The periosteum is incised longitudinally and separated from both fragments for a distance of three inches from the site of the fracture Both fragments are then split longitudinally with a motor saw along the narrow side of the bone The superficial portion of the fragment, consisting of at least one-half the entire thickness of the bone, is removed The entire piece, whether taken from the upper or the lower fragment, is then employed as a large, broad, bone graft The fragments are brought into proper alignment and this bone plate is fastened to both fragments securely with metal screws The portion of bone removed from the other fragment is discarded and in some instances in fractures near the lower end of the radius the superficial part of the lower fragment is elevated by making a green-stick fracture at its base and the bone plate is inserted beneath it In such case the screws pass through three pieces of bone in the lower fragment The periosteum is sutured over the bone plate The arm is dressed in a plaster bandage If

## BILATERAL EMPYÆMA

there is separation of the fragments in these cases of non-union due to absorption of the ends no attempt is made to bring the ends together. The large bone plate spans the gap between the two bones. Patients operated on in this manner have been able to return to hard work three months after the operation. Metal screws are used in preference to bone grafts because the latter are more fragile and apt to break. The screws remain permanently in place. They become completely covered with bone formed underneath the periosteum.

## SPONTANEOUS PNEUMOTHORAX

DRS GEORGE P. MULLER and FRANCESCO MOGAVERO read a paper with the above title

## BILATERAL EMPYÆMA

DOCTORS MULLER and MOGAVERO reported the case of a woman, aged thirty-one years, who was admitted May 21, 1931, to Misericordia Hospital in the service of Doctor Muller with the chief complaint of chills, fever, pain in right side of chest and cough with expectoration. She was apparently healthy until May 17, when she was taken ill with a "cold," cough, fever, headache and general malaise. She spent one day in bed and was up and around for several days, and then suffered a relapse and was taken suddenly with chills, fever, pain in right chest, cough with copious expectoration which was blood streaked.

When admitted she was markedly dyspnoëic, suffering a great deal of pain with each respiratory movement. Respirations were rapid and shallow due to pain. Her lips were slightly cyanotic. The chest anteriorly revealed a lagging over the right side on expansion, impaired resonance in the right middle lobe, bronchial breathing and increased vocal fremitus. The upper right lobe showed numerous coarse râles. In the left lobe were found many scattered coarse râles.

Temperature, 101°, pulse, 140, respiration, 46

*Diagnosis*—Pneumonia involving the lower and middle right lobes. At the time of admission she was six months pregnant. On the third day thereafter she gave birth to a living child with intact membranes. The placenta came away spontaneously. The foetus died shortly after delivery.

The patient's condition for the next ten days was poor. Examination showed a left empyæma present.

June 3, thoracentesis was performed and 275 cubic centimetres of pus removed from the left chest at the eighth interspace, posteriorly. The following day, the patient became very dyspnoëic and thoracentesis was repeated with removal of 400 cubic centimetres of pus from the left chest with some relief. The existence of a bilateral effusion was determined. (Fig 3.)

On June 5, left thoracotomy was performed. The drainage tube was attached to a Hart apparatus for tidal irrigation as modified by Overholt. The solution used for irrigation was normal salt solution.

After operation, the patient was improved sufficiently to permit right thoracotomy which was performed June 15. The tidal irrigation was stopped on the left side, closed drainage still carried out, placing end of tube under water in a bottle. Blood transfusion of 500 cubic centimetres of citrated blood given. The patient did well, closed irrigation was stopped and drainage into dressings permitted. She was discharged August 4, 1931, with a

final note that the wounds were healed, slight amount of fluid present as reported by last X-rays Temperature was normal (Fig 4 )

Six months later the patient reported that she had been well since discharge from the hospital

DOCTOR MOGAVERO added that bilateral empyæma is not an infrequent complication following pneumonia Most authors agree that empyæma is bilateral in less than 5 per cent of the non-fatal sporadic cases In 603 autopsies of empyæma cases, Dunham found that 43 per cent were bilateral, Hellen states that 77 per cent of all empyæma cases are bilateral, Tod that 20 per cent and Tholt 3 per cent The majority of these occur, according to Curtis and Bowman, during the early decades of life, and males are affected in 65 per cent of the cases Graves reports that it is frequent in children under ten and in adults beyond middle life He reports a series of twenty cases spread over the various age groups thus Thirteen, or 65



FIG 3—Showing bilateral empyæma



FIG 4—End result

per cent, in first decade Three, or 10 per cent, in second decade Two, or 10 per cent, in third decade Three, or 15 per cent, in fourth decade

Scanlan, in 1928, collected in the literature up to that time 248 cases, Graves reported in 1928 twenty cases, and Keyes forty-four cases, having a total of 312 cases Graham states that bilateral empyæma occurs more frequently in the streptococcus cases (hemolytic) than in the pneumococcus However, others disagree, Graves found that staphylococcus and pneumococcus were the predominating organisms Keyes, in his series, found that the pneumococcus was most commonly present, Curtis and Bowman that the pneumococcus was found in 70 per cent, the streptococcus in 14 per cent In 1917-1918 there was a reversal of these figures, 73 per cent due to streptococcus and 23 per cent to pneumococcus Curtis and Bowman found that the staphylococcus was a rare offender and report a case of staphylococcus empyæma following a carbuncle of the neck

Most writers found that three-fourths of the cases followed broncho-pneumonia and that it may occur as a complication following influenza, measles, scarlet fever and puerperal sepsis. Bilateral empyæma occasionally follows when the pneumonia is demonstrable in but one lung. In Keyes' series of cases, the death rate was 19.5 per cent, and in Fabrikant's series of 118 cases, 37 per cent.

Treatment of bilateral empyæma varies with every writer and the following will give a general idea of methods employed. Hedbloom advocates bilateral simultaneous closed drainage, Auer, closed drainage, aspirating the largest one first, and then an open drainage of this side and a closed drainage of the other. Markley in his case did, first, bilateral aspiration and then bilateral rib resection, however, did not state whether open or closed type used. Scanlan in his case employed bilateral aspiration, then a bilateral thoracotomy, these at three-day intervals, Beck's case, bilateral thoracotomy. Ravnitzky and Bogia report two cases, in one a bilateral rib resection with a twenty-six-day interval and in the other, one side aspiration and other side rib resection thirty-seven days later. Matthews advocates aspiration and closed drainage, Graves, rib resection, open drainage type, interval of five days. Keyes advocates a high fluid and caloric intake, and simultaneous drainage. He states that the patient is not relieved a great deal after the first thoracotomy and tends to remain very little changed until after the second thoracotomy, that delay seems to accomplish little but weaken the powers of resistance. If delay must be carried out and empyæma of both sides is equal, operate on the left one first, thus relieving cardiac embarrassment, if empyæma is unequal, operate on the larger one first. The initial drainage is to be closed type to fixed things and then open type. Curtis and Bowman performed a bilateral interval closed drainage, later bilateral rib resection and unilateral phrenic exeresis, the interval between thoracotomies was nine days. Beck reports a case of bilateral empyæma complicated by childbirth during attack of influenza. The woman was thirty-four years old, pregnant eight months, giving birth to normal living child at the time. He states that nearly always the mother and child die. He advocated rib resection with closed drainage, stating that both sides should not be drained simultaneously, but to give the lung a chance to expand, the interval in his case was twenty-four days.

DR DAMON B. PFEIFFER recalled two cases of acute pneumothorax, both of whom presented at the onset all the symptoms of abdominal catastrophe. The first patient was a young man who had suddenly developed epigastric and right-sided abdominal pain. The temperature and pulse were about normal and the respirations moderately elevated. The abdominal muscles were tense, particularly on the right side. The first impression was perforated ulcer. Percussion of the chest yielded a high-pitched, tympanitic note on the right side with a complete absence of breath sounds. The heart was shifted to the left. The patient was removed to the hospital. X-ray examination gave a characteristic picture of a small collapsed lung lying

tight against the hilum. The abdominal symptoms soon passed off, the patient made a complete recovery and has remained well for six years. The second case was more recent and presented a very similar picture. The origin of the pneumothorax in both cases has remained obscure. Neither patient has presented either clinical or X-ray evidence of tuberculous involvement of the lung. There was no strain or history of accident. About nine months ago an acute pneumothorax developed suddenly in another patient during convalescence from operation for carcinoma of the cæcum. This was accompanied by collapse, dyspnoea and severe epigastric pain. It was at first thought that obstruction or some other intra-abdominal complication was going on. Examination of the chest followed by X-ray cleared up the diagnosis. The patient went on to an uncomplicated recovery and has remained well.

It might be pertinent to call attention to the simulation of abdominal disease by certain anginoid heart attacks. The older clinicians recognized this and spoke of abdominal angina. Years ago Murphy called attention to mediastinal lesions as a cause of paralytic ileus simulating obstruction. It has been of interest to note that in the present wave of so-called grippe or influenza, symptoms in many cases have strongly suggested appendicitis or other intra-abdominal surgical lesions. The differentiation has often been extremely difficult or impossible. The rôle of certain forms of pneumonia and basal pleurisy in mimicking abdominal disease is, of course, well known.

DR GEORGE P. MULLER remarked that when he examined the first patient on admission he was certain he had a perforated peptic ulcer. Some years ago he observed a patient with violent epigastric pain in whom acute pancreatitis was suspected. Operation was not done and twenty-four hours later pain recurred and the patient died. At autopsy a ruptured dissecting aneurism of the thoracic aorta was found with mediastinum and pleura full of blood. In the second case a tumor of the thymus had perforated or ruptured. The mediastinum at autopsy contained organized blood-clots but when seen by the speaker his symptoms were those of an acute epigastric lesion, possibly pancreatitis. An X-ray of the chest revealed the true nature of the lesion.

The case of bilateral empyæma was the first one he has seen for ten years. Possibly in a similar case he would be tempted to operate in two stages with only a few days' space between them.

#### TRAUMATIC RUPTURE OF STOMACH, COLON AND KIDNEY

DR WILLIAM T. LEMMON reported the case of a boy, eleven years of age, who was admitted to the Philadelphia General Hospital June 15, 1932, in the surgical service of Dr. Hubley R. Owen, about twenty hours after a fall from a board fence. He struck the anterior right lateral surface of his abdomen, his body landing in a jack-knife position across the fence. He was knocked breathless but did not lose consciousness. After sitting on the

curb for about fifteen minutes, he started home, aided by his playmates. He made frequent stops on account of extreme weakness and dizziness. During the night, he was very restless and suffered pain. He asked constantly for ice and ice water. He vomited several times. He neither voided nor had a bowel movement during the night. The following morning at 9.30 he passed less than 100 cubic centimetres of bloody urine. He also passed fresh blood and blood-clots by bowel. Vomiting and thirst continued. On admission to the hospital the following afternoon, the abdomen was markedly distended, tender and rigid. The rigidity was more marked over the entire right side of the abdomen and the right loin. The percussion note was tympanitic except in the flanks, where it was flat. Feeble peristaltic sounds were heard only over the left upper abdomen. There were no visible signs of injury to the surface of the abdomen, loins, or elsewhere on the body. Temperature  $100^{\circ}$ , pulse, 148, respirations, 22 per minute. The urine examination showed blood grossly and microscopically. The blood count revealed 11,500 leucocytes, 3,120,000 red blood-cells, and hæmoglobin of 62 per cent.

Previous to operation, 5 per cent glucose in 400 cubic centimetres of normal saline was given intravenously. Twenty-one and a half hours after the accident, under ether anaesthesia, a left paramedian incision was made. The left rectus incision was made because of the possibility of injury to the spleen. The peritoneum was dark in color and the peritoneal cavity contained approximately 1,200 cubic centimetres of bloody fluid, blood-clots, inflammatory lymph, which had a fecal odor. Blood was present in the greater peritoneal cavity, the lesser peritoneal cavity, and in the retroperitoneal tissues on the right side of the abdomen. A systematic examination of the abdominal organs revealed the liver, spleen, pancreas, left kidney, jejunum, descending colon, sigmoid, rectum, and bladder to be uninjured. The mesentery to the terminal ten inches of the ileum was torn and that part of the ileum was dark in color, cold to the touch, and did not respond when hot packs were applied. The circulation was so badly disturbed that resection of that portion was considered necessary. The cæcum had several small complete tears, each about one to two inches in length, extending through all the coats. These openings were plugged by the mucosa and blood-clots. The cæcum was also markedly distended, dark in color, and filled principally by blood and blood-clots. A similar but less marked condition was found in the ascending colon. The right half of the transverse colon was dark in color, cold to touch, and did not regain its color after hot pack applications. The mesocolon of that part of the colon was found to be torn and bleeding. A large, dark fluctuating mass was found in the anatomical position of the right kidney. This mass extended along the course of the right ureter to the brim of the true pelvis. There was a subperitoneal rupture of the posterior wall of the stomach with a hæmatoma about two inches in length. This bleeding was controlled by two Lembert sutures. The terminal ileum, appendix, cæcum, ascending, and the right half of the transverse colon were resected. When the peritoneum, lateral to the cæcum and ascending colon, was incised and reflected medially, there was profuse hæmorrhage from the right kidney. This delayed hæmorrhage was probably due to the release of pressure and the dislodgement of clots which served to check and lessen the renal bleeding. The clots were removed from the region of the right kidney and also the lateral half of the kidney. There was profuse bleeding from the remaining portion of the kidney. This hæmorrhage was checked by clamp and ligature. The remaining portion of the kidney was

then removed. A lateral isoperistaltic anastomosis was made between the terminal portion of the remaining ileum and the proximal portion of the remaining transverse colon. Complete hæmostasis was secured and all raw surfaces were peritonealized. The peritoneal cavity was irrigated with hot normal saline. Approximately one pint of this solution was left within the cavity. The abdomen was closed without drainage. During the operation the patient received 100 cubic centimetres of 5 per cent glucose and 200 cubic centimetres of normal saline intravenously. At the conclusion of the operation, he was given 90 cubic centimetres of blood by transfusion with immediate improvement. During his convalescence, which was uneventful, he was given blood transfusions, glucose, and normal saline. July 22, he was discharged in good condition.

This boy, approximately five months after operation, is in perfect health. An X-ray examination made before discharge from the hospital showed the terminal ileum joined to the proximal end of the remaining portion of the transverse colon. The intestinal function was normal. The pathological report of the kidney showed an acute purulent exudate, in addition to traumatic rupture and hæmorrhage. The cæcum showed gangrene in addition to ruptures and hæmorrhage.

Aristotle's observation that the intestine of a deer is so fragile that a blow will cause it to rupture without injuring the skin, is perhaps the first record of injury to the intestine following abdominal contusion without external signs of trauma. It was not until the seventeenth century, when post-mortem examinations became more common, that traumatic intestinal perforation was given its due recognition as an important surgical condition.

Moynihan states that the first laparotomy for rupture of the intestine was performed by Bouilly, in 1833. The first successful case was operated upon by Croft in 1889. Examination of the literature shows that traumatic rupture of the large intestine is much less frequent than that of the small intestine but that both may be ruptured at the same time. The reporter had not found a recorded case of rupture of the kidney complicating rupture of the colon with recovery of the patient. According to Moynihan, emphysema is the only sign that is characteristic of lesions of those portions of the bowel which are not wholly covered by peritoneum (parts of the duodenum and the ascending and descending colon). If the usual symptoms of intestinal injury and emphysema in the right flank are present, a diagnosis of rupture of the ascending colon or of the duodenum may be made. Emphysema spreading from the descending colon may be noticed first in the left flank.

The large intestine is not so frequently injured as the small intestine. In a total of 221 cases collected from London hospitals, Berry records 177 injuries of the small intestine, twenty-nine of the duodenum, and fifteen of the large intestine. Other statistics give practically identical results.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD DECEMBER 14, 1932 AT THE PRESBYTERIAN HOSPITAL  
OF NEW YORK

### COMPLICATIONS OF FRACTURES IN THE AGED

DR WILLIAM DARRACH, M D, from the Surgical Service of the Presbyterian Hospital, presented the subject of the complication of fractures in the aged. He said: Fractures in the aged are serious because of the complications. When elderly people are kept in bed, they are apt to get hypostatic pneumonia and die, so we must roll them over and sit them up as soon as possible. Four years' experience in the Fracture Ward has proved to us the truth of this idea. It has also shown us that the problem is not quite as simple as that.

There are two types of complicating conditions in which we have been greatly helped by the work of Bancroft and Stanley-Brown. In one type we find old people who have survived the first shock of their injury who, seemingly on the road to recovery, begin to get drowsy and drop off to sleep more and more frequently and more deeply. Soon they cannot be aroused and finally drift off in a quiet, peaceful death. Other groups include those who show an unhappy tendency to clot. They have one or more attacks of thrombo-phlebitis either with or without pulmonary infarction. Many of these two classes show a disturbance of the clotting index. Such cases have been very materially improved and sometimes brought back to normal by the use of sodium thiosulphate and diet. In several instances, the reaction has been startlingly satisfactory.

A simple rehearsal of other complications we have met seems to be the best method of presenting this picture.

A woman of eighty-three with a fracture of the base of the neck of the femur had marked cardiac arrhythmia. She developed pneumonia and died on the ninth day.

A woman of seventy-five with a comminuted fracture of the upper extremity of the humerus had a severe nephritis. She became irrational on her second day and died from pneumonia on her twelfth.

A man of eighty-six with a fracture of the base of the femoral neck with marked hypertension and arterio-sclerosis was awakened from a drowsy stupor twice by sodium thiosulphate, but failed to respond a third time and died on the sixty-fourth day. Autopsy showed solid bony union.

A woman of eighty-three with fracture of the base of the femoral neck developed a senile psychosis that cleared up completely on sodium thiosulphate. She died eight months later in the city hospital.

A woman of sixty-six with an intertrochanteric fracture developed a coronary thrombosis in her fourth week and died.



A man of seventy-six with an intertrochanteric fracture of the femur did splendidly until his thirty-first day when he ruptured his gall-bladder and died within twenty-four hours

A woman of seventy-three stood a Smith-Petersen open reduction very well until the operation was finished, when she suddenly became cyanotic and autopsy showed a large saddle clot in her pulmonary vessels

A woman of seventy with a high fracture of the neck of the femur developed a musculo-spiral paralysis during application of a plaster case which delayed convalescence through her inability to use crutches

A woman of seventy with a fracture low in the neck of her femur developed a noisy senile dementia requiring restraint and was sent to Bellevue

A woman of seventy-one with an intertrochanteric fracture had a large decubitus on her leg requiring skin grafting on the ninety-ninth day

A woman of seventy-two with a fracture of the neck of the femur, marked cystitis and incontinence, had such violent paralysis agitans that she jiggled off the adhesive together with large areas of skin

A woman of seventy-four with a Smith-Petersen reduction of the hip developed a thrombo-phlebitis on her fifty-fourth day and had two severe cerebral attacks afterwards. She was aided by sodium thiosulphate and is now walking with solid union

A woman of seventy-four had a Smith-Petersen open reduction and on the day after the operation developed a vaginal hæmorrhage severe enough to require packing

A man of seventy-five with a bad prostate and uræmia fell out of bed breaking his hip which complicated his uræmia—fatally

A woman of seventy-seven with a fracture of the neck of the femur, with bad cystitis and pyelitis, developed an acute appendix on her twenty-fourth day. A decubitus on her heel delayed her walking for many months

A man of seventy-eight with Paget's disease and a fracture through the shaft of his femur with muscular interposition was greatly helped during his convalescence by sodium thiosulphate, but a decubitus on his heel delayed his convalescence for many months

A woman of eighty with a fracture of the neck of the femur was given sodium thiosulphate after her second pulmonary infarction. She recovered without any more attacks

A man of eighty-four with an oblique fracture of the shaft of the femur, bad chronic cystitis and marked arterio-sclerosis, had an attack of thrombo-phlebitis and auricular fibrillation. He also had two cerebral attacks in one of which there was marked Cheyne-Stokes breathing. He seemed greatly helped by sodium thiosulphate and walked out of the hospital with solid union

A woman of eighty-four with a subtrochanteric fracture of the femur which was complicated by a severe uterine prolapse. She became very drowsy on her sixty-third day and on the ninety-second day developed bronchial pneumonia. Seventeen months later she was walking with a moderate limp

A man of eighty-eight with a fracture through the base of the neck of the femur was greatly disturbed by a thrombosed hæmorrhoid which required operation

A woman of sixty-eight had a fracture through the trochanters and a blood-pressure of 260 with high blood-sugar. She celebrated her release from her brace at the end of nine months by again falling and breaking the other hip. She succeeded in getting solid bony union in both hips

A man of seventy-one with a compression fracture of his upper lumbar vertebra caused us great anxiety by persistent and extreme abdominal distension for the first few days

## DIAGNOSIS OF CHOLELITHIASIS

A man of eighty-one with a fracture of the pelvis was complicated by the presence of a large stone in the bladder with cystitis

We have had the usual complications of carcinoma with pathological fractures

A woman of sixty-eight with a fracture of the neck of the femur was greatly disturbed by herpes zoster involving the groin and buttocks

It is difficult to predict what the complications of fractures in the aged will be

### THE DIAGNOSTIC VALUE OF BILE OBTAINED THROUGH A DUODENAL TUBE—WITH ESPECIAL REFERENCE TO THE DIAGNOSIS OF CHOLELITHIASIS

DRS LOUIS M ROUSSELOT and LOUIS BAUMAN presented a note stating that during the past ten years there has been a gradual accumulation of evidence by various investigators tending to show that the association of cholesterol crystals in duodenal bile and gall-stone disease is more than a coincidence

Lyon Hollander Mateer and Chester Jones all felt that the presence of many clumps of cholesterol crystals probably signified the presence of gall-stones Recently Bockus presented a large, carefully studied group of cases and concluded that the presence of cholesterol crystals or calcium bilirubin pigment or both in bile obtained by a duodenal tube was positive criteria for the diagnosis of gall-stones

Similar studies have been repeated and somewhat elaborated at the Presbyterian Hospital during the past year and a half \* A technic has been adopted that greatly simplifies and hastens the passage of the duodenal tube All intubations are checked as to position by using the fluoroscopical table The identification of the crystalline elements and calcium bilirubin pigment in the bile sediment is not difficult

Our experience has been summarized and arbitrarily divided into the following four groupings A comparison with the X-ray findings and the operative findings is also given

TABLE I

*Cases Yielding Dilute ("A") Bile Without Cholesterol Crystals or Calcium Bilirubin*

(1) Total number in group	30
(2) Cholecystogram	25
(a) Abnormal response	24
(b) Normal response	1
(c) Accurate interpretation 23 out of 25	92%
(3) Duodenal drainage	30
(a) Laboratory diagnosis of chronic cholecystitis with or without stones	29
(b) Laboratory diagnosis of normal gall-bladder	1
(c) Cases in which failure to recover "B" bile was unexplained by operative findings	8
(d) Accurate interpretation 22 out of 30	73%

\* Cholesterol Crystals and Calcium Bilirubinate Granules Their Significance in Bile Obtained Through the Duodenal Tube Louis M Rousselot and Louis Bauman J A M A Vol 100, p 254, Jan, 1933

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TABLE II

## *Cases Yielding No Bile*

(1) Total number in group	7
(2) Operative findings	
(a) Calculi in common duct with obstruction	3
(b) Carcinoma of the head of the pancreas	2
(c) Carcinoma of the papilla of Vater	1
(d) Cicatricial stenosis of the common duct	1

TABLL III

## *Cases Having Neither Cholesterol Crystals Nor Calcium Bilirubin in So-called 'B' Bile*

(1) Total number in group	14
(2) Cholecystogram	12
(a) Abnormal response	6
(b) Normal response	4
(c) Equivocal findings	2
(d) No X-ray	2
(e) Accurate interpretation 5 out of 12	42%
(3) Duodenal drainage	14
(a) Accurate interpretation	64%
(i) No stones or cholesterosis of the gall-bladder	

TABLL IV

## *Cases Having Cholesterol Crystals or Calcium Bilirubin or Both These Substances in Bile*

(1) Total number in group	53
(2) Cholecystogram	44
(a) Abnormal response	36
(b) Normal response	4
(c) Equivocal findings	4
(d) No X-ray	8
(e) Accurate interpretation 36 out of 44	84%
(3) Duodenal drainage	53
(a) Accurate interpretation 51 out of 53	96%

(These tables were shown as lantern slides)

We wish to state that this test is not done routinely on all cases of biliary-tract disease but is reserved for those cases in which the diagnosis is vague and in which there is no confirmatory X-ray evidence. It is used almost routinely in jaundice cases to establish the presence or absence of bile in the duodenum.

As a result of this study we have reached the following conclusions:

(1) The failure to obtain concentrated "B" bile after two or more drainages is suggestive of intrinsic disease of the gall-bladder.

(2) The absence of cholesterol crystals or calcium bilirubin pigment in concentrated "B" bile is fairly strong evidence against the presence of stones.

(3) The finding of cholesterol crystals or calcium bilirubin pigment in dilute "A" bile or "B" bile is almost pathognomonic of the presence of gall-stones.

## WOUND INFECTION

### THE CONTROL OF WOUND INFECTIONS

DR FRANK L MELENEY stated that in the spring of 1925 a high incidence in the Presbyterian Hospital of wound infections in clean cases led to the careful study of wound infections. It appeared that the percentage of infections was much higher than any one had suspected, and each year the study has been of such interest that it has been continued. Such a study tends to improve the sterile technic of the service and encourages care in the making of accurate observations on wound healing.

During the first spring the immediate problem was to find the cause of the hemolytic streptococcus wound infections. There were nine of these in the first five months of 1925. In searching everywhere for the hemolytic streptococcus we found that there were 33 per cent of carriers among the operating personnel. Right after this survey had been made, another hemolytic streptococcus infection developed in a hernia. It was found that three of the persons on the operating team had hemolytic streptococcus in the throat and one of them, the instrument nurse, had them in the nose as well. (At that time we were masking the mouth rather indifferently and not covering the nose at all.) Curiously enough, the patient also had hemolytic streptococcus in his nose and throat. With all of these strains we immunized rabbits and determined by agglutinin and absorption of agglutinin tests that the strain recovered from the wound of the patient was identical with the strains from the nose and throat of the instrument nurse and different from those from the patient's own nose and throat and the throats of the operating surgeons.

Ever since then we have strictly masked nose and mouth of every one entering the operating rooms, not only the sterile operating team but anæsthetists, unsterile nurses and orderlies. There was an immediate disappearance of hemolytic streptococcus infections and there have only been sporadic cases since. With sporadic cases there is a seasonal incidence of hemolytic streptococcus wound infections, there being eight times as many in the first six months of the year as in the last six months, but, with hemolytic streptococcus wound infections reduced to a minimum, this does not hold true for wound infections in general for a summary of seven years shows that the monthly incidence hardly varies at all.

In a search for other sources of infection we have taken into account the nature of the bacteria found. For example, in a representative year (1930) of the total number of species found on culture there were Hemolytic Streptococcus, 4 per cent, Non-hemolytic Streptococcus, 10 per cent, Hemolytic Staphylococcus aureus, 15 per cent, Staphylococcus aureus, 20 per cent, Staphylococcus albus, 22 per cent, B coli, 7 per cent, B subtilis, 6 per cent, B proteus, 1 per cent, B pyocyaneus, 1 per cent, Diphtheroids, 5 per cent, and others, 4 per cent.

Other sources of infection which seem to be important are (a) materials, instruments and solutions, (b) skin of the patient, (c) hands of the operators, and (d) air of the operating room.

Cultures of the materials have uniformly yielded no growth. As skin antiseptics we compared iodine with mercurochrome-acetone-alcohol in a series of patients. We snipped bits of skin from the hair line of hernias and obtained growth in eight out of ten prepared with iodine and in nine out of ten prepared with mercurochrome. The organisms found were chiefly staphylococci and spore forming organisms. Of these, two of the iodine cases had trivial infections and one of the mercurochrome cases had a serious infection. Since then we have experimented on animals in a similar manner with all of the advocated skin antiseptics and find that none really sterilizes the skin. Probably organisms in deep hair follicles and sweat glands are not reached by the antiseptics. Until we have a skin antiseptic which will sterilize the deep layers of the skin, that will always be a source of contamination.

In studying the source from the hands of the operators we have found that after a dressing without gloves, even though great care is taken, organisms from the infection are picked up by the hands of the doctors and nurses.

In studying the contamination from the air we exposed culture plates and found that down in the old hospital, with the operating rooms on the ground floor, two colonies of bacteria grew out on the plates for every minute of exposure. When we moved uptown and tested the operating rooms on the sixteenth floor supplied with filtered air, this figure was cut in half. When we compared a room in which an operation was going on, with people moving about and doors opening and closing, with a corresponding operating room in which there was no operation going on and no moving about, we found that there were ten times as many colonies on the culture plates from the active room as on the plates from the inactive room.

The study showed further that drained wounds are more apt to become infected than undrained wounds but we are not sure whether this is due to the drains or to the nature of the condition for which the drains were used.

Hematomas, however, markedly increase the percentage of infection. If not infected at the time of the first dressing, many of these become infected later.

Certain types of operation seemed to favor wound infection. Up to 1929, a particularly high incidence of infection occurred in radical mastectomies, thyroids, open reduction of fractures, recurrent and ventral hernias, double operations and excision of lipomas. There seemed to be a plausible explanation for all but the thyroids. In this group we were getting not only a high incidence of infection but many hematomas. Most of the thyroids were being done by the two surgeons connected with the thyroid clinic. In the summer of 1929, in the absence of one of these surgeons, one of the staff, who had recently come from another clinic where silk was being used more generally, operated on five thyroids and used silk instead of catgut. The soft, clean healing of these wounds was seen by the second thyroid surgeon and he decided to try it. He operated on ten cases with silk and then on ten with catgut. The silk cases all healed cleanly and the catgut cases had four hematomas and two infections. Then he changed over en-

## SUTURE MATERIAL AND WOUND REPAIR

tirely to the use of silk and a little later in May, 1930, the other thyroid surgeon followed his example. Since then practically all of the thyroids have been done with silk with marked reduction both of hematomas and infections, as is seen in Table I.

This striking improvement in thyroid cases led to the greater use of silk in hernias and open reductions with equally gratifying results when the figures were completed for 1931. (See Table II.)

The incidence of infection in open reduction fell from 26 per cent to two per cent and although there were some other changes in technic this seemed to be due almost entirely to the substitution of silk for catgut. We believe that this favorable response is probably due to the minimal tissue reaction which silk produces, to the greater security of hemostasis with silk and to the gentler handling of tissues which the use of silk requires.

During the past seven years our serious wound infections have been reduced from 4 to 17 per cent and the trivial infections from 10 to 5.4

TABLE I  
*Thyroid Operations*

	Totals	Infect	%	Hemat.	%
1926	57	10	18	16	28
1927	77	13	17	30	39
1928	78	8	10	29	37
1929	163	20	12	60	38
1930	189	4	2	29	15
1930 Catgut	35	2	6	15	43
1930 Silk	154	2	1	14	9
1931	216	4	2	29	13
1930 Av	num. days in Hosp				
" "	" "	" "	" "	Catgut - 12	
" "	" "	" "	" "	Silk - 9	

TABLE II  
*1931 Silk versus Catgut*

	INGUINAL HERNIA						FRACTURE SERVICE					
	Total	Hem.	%	Ser.	Triv.	% Inf.	Total	Hem.	%	Ser.	Triv.	% Inf.
CATGUT	100	14	14	1	4	5	38	11	29	2	5	18
SILK	49	0	0	0	0	0	79	1	1	0	0	0
SILK & GUT	8	2	25	0	3	38	10	4	40	0	1	10
NOT STATED	5	0	0	0	0	0	10	0	0	0	0	0
Totals	162	16	10	1	7	5	137	16	12	2	6	6

per cent. We do not feel that we have reached the irreducible minimum of wound infections and will continue to strive to reduce their incidence still further.

### EFFECTS OF SUTURE MATERIAL ON THE TENSILE STRENGTH OF WOUND REPAIR

DR EDWARD L. HOWES remarked that from the point of view of strength, the function of the suture is to hold the wound edges in apposition until the wound through the process of healing has acquired a strength of its own. Simple incised wounds made in fascia, muscle, peritoneum, and skin sutured with the finest of suture material have a period of four to five days when the strength of the wound is only that attributable to the holding power of sutures. Moreover, this holding power of sutures is more dependent upon the nature of the tissues holding them than upon the thread strength of the sutures. Thus fascia has a greater holding power than muscle. When cat-

gut is used to repair a wound, its thread strength tends to diminish during this first period while the strength of silk remains unchanged. There is also some loss of the holding power of the tissues during this period.

Following this first phase of healing, the wound rapidly increases in strength as a result of the proliferation of fibroblasts and epithelial cells. The time when this second period begins and the rate at which it proceeds depend entirely upon the length of the first period. The length of the first period, in turn, depends upon the extent and character of the exudative reaction. Infection and necrosis prolong the first period and consequently the strength of the second period is manifested later and develops at a slower rate.

Sutures in the wound are foreign bodies and therefore should influence both periods of healing. Besides, the method by which they have been inserted, the tightness with which they were tied, and perhaps their very nature can prolong the first period of healing and subsequently affect the second period.

To demonstrate whether suture materials by their very nature can affect the tensile strength of the healing wound, rectus-splitting incisions were made on either side of the abdomen by Doctor Whipple and Doctor Vivier in a series of dogs. To control trauma and variations in the amount of suture material employed, sutures of exactly the same size and strength were used in both wounds and were employed in exactly the same manner. On one side, interrupted No. 000 plain catgut sutures were used for the peritoneum, interrupted No. 000 chromic catgut for the fascia, and interrupted silk for the skin. On the opposite side, interrupted sutures of A-silk were employed in the same manner. The thread strength of No. 000 catgut is five to six pounds. The thread strength of A-silk varies from three and three-quarters to four and three-quarter pounds. The wounds were tested for strength at daily intervals after suturing, leaving the skin sutures in place.

The results showed that in every instance the wounds sutured with silk were stronger than those sutured with catgut. Besides, in two of the wounds sutured with catgut separation of the peritoneum had occurred, yet these and all of the other wounds appeared to have healed per primam externally. The two wounds with the separations of tissue were not tested for strength.

The number of observations in these experiments on the wounds in dogs were too few in number to tell whether there was a difference in the length of the first period of healing, or whether there was a difference in the rate of accumulation of strength during the first part of the second period. Other experiments on rats have illustrated these points. These wounds in the stomachs of rats were sutured with different sizes of silk and catgut. The strengths of these wounds were tested at daily intervals by distending the stomachs with air and the results are therefore expressed in millimetres of mercury. The details of this method have been described before. Five wounds were tested each day and the data were sufficiently explicit to give smooth curves of healing strength. The results showed that with silk the first period of healing was shortened. With catgut, the first period was

prolonged Correspondingly, the wounds sutured with catgut had less strength in the beginning of the second period than the wounds sutured with silk This more rapid appearance of healing strength with silk and the greater strength of the wounds during the beginning of the second phase of healing occurred regardless of the size of the catgut or silk suture used The difference, therefore, is attributable to the nature of the suture material rather than its size It must be pointed out, however, that even though different sizes of both silk and catgut were used without demonstrable differences in strength, none of the sizes employed were of such exaggerated dimensions that healing was interfered with Examples of the fact that extremely large sizes of catgut retard healing more than the finer sizes of catgut have already been demonstrated by Doctor Harvey and myself

Microscopical sections have been made of all of these wounds and will be described in the final publication of this work

#### ONE THOUSAND SPINAL ANÆSTHESIAS

DR LAWRENCE W SLOAN submitted a report as part of a study of the use of spinal anæsthesia at the Presbyterian Hospital of New York made by Dr Louis M Rousselot and the speaker, saying that the report was really a study of a group of operative cases in which spinal anæsthesia was employed, that is to say, the group was studied from the point of view of the patient as an operative risk in relation to the anæsthetic rather than to obtain isolated statistics with reference to the anæsthetic A more complete presentation of the study was contemplated

The group of 1,000 includes the cases that were operated on under spinal anæsthesia between January, 1928, and May, 1932 This major group has been subdivided into two groups (1) Those between January, 1928, and January, 1931 (596 cases), and (2) those from January, 1931, and May, 1932 (404 cases) A third more recent group of 100 cases was also briefly reported compared with the other groups The cases in this last group were anæsthetized under a technic differing from the preceding cases chiefly by the larger doses of anæsthetic drug and ephedrine used, the abandoning of the Trendelenburg position and the use of larger pre-operative doses of sedatives (The earlier technic was essentially the Labat method)

The following charts were shown to present briefly some of the findings

In Chart I the results based on both the entire 1,000 cases and the results in the group of 596 cases are presented The more detailed analysis was made on the latter group because in this group more complete records were kept This group of 596 cases also really represents a selected group because in it were included many very poor risks, the choice of the anæsthetic being made on that account This undoubtedly explains the high *gross* mortality rate (13.6 per cent) for the group of 596 cases (whereas for the entire group the rate is 11.8 per cent and for the more recent group of 100 cases 8 per cent)

About one-fourth of the cases (27.5 per cent) required a supplementary



anæsthetic The incidence of failures was 5.2 per cent The average blood-pressure drop for intra-abdominal and extra-abdominal operations was almost the same (49/29 and 45/23 respectively)

Whereas the incidence of minor respiratory complications before operation was relatively high in the unsupplemented spinal anæsthesias, the incidence of post-operative pneumonia was relatively low In the supplemented cases, however, the converse held true In those cases complicated by a major respiratory complication before operation, post-operative pneumonia almost invariably followed The incidence of other post-operative complications is also shown in the chart The highest rate of incidence for both

Chart 1	Number	Percent	Blood Pressure Drop (Average)	Minor Pre op Respiratory Complications	Major Pre op Respiratory Complications	Post op Pneumonia	Severe Post-op Nausea Vomiting Distention	Severe Post op Headache Paralysis	Post op Cardio Vascular Complications	Post op Difficulty Voiding Renal Shut down	Deaths (Based on 1000 Cases)
Based on Analysis of 596 Cases											
Total Cases	1000	100									118 <sup>9</sup> 11.8%
Unsupplemented Intra abdominal Ops	463	46.3	49/29	26.9%	15.6%	10.5%	16.4%	1.9%	16.0%	2.2%	58 <sup>12.5%</sup>
Unsupplemented Extra-abdominal Ops	262	26.2	45/23	22.8%	13.6%	6.5%	2.6%	2.6%	7.8%	1.3%	16 <sup>6.1%</sup>
Total Unsupplemented Ops	725	72.5	48/28								
Supplemented Intra abdominal Ops	227	22.7		10.8%	9.4%	12.2%	22.3%	.72%	21.6%	4.3%	34 <sup>17.2%</sup>
Supplemented Extra abdominal Ops	48	4.8		14.3%	14.3%	14.3%	7.2%	0	10.7%	3.6%	5 <sup>10.4%</sup>
Total Supplemented Ops	275	27.5									
Total Intra abdominal Ops	690	69.0									
Total Extra-abdominal Ops	310	31.0									
Spinal Failures	52	5.2									
Duration of anaesthesia (120 mgs neocaine)			52 mins 76% lasted for duration of operation when op lasted 1 hr to 1 hr 15 mins 32.6% lasted for duration of operation when op lasted 1 hr 15' to 1 hr 30'								
Mortality rates			40 yrs - 50 yrs 8.45% 50 yrs - 60 yrs 25.4%								
* Spinal deaths (596 cases)			Apparently direct result of anaesthesia 1 (0.2%) In which, anaesthesia was thought contributory 18 (3.0%) Total 19 (3.2%) Aver Bp drop 82/50								

complications and mortality was found to be in the supplemented intra-abdominal group

The average duration of the anæsthetic (120 milligrams of neocaine) was fifty-two minutes Only about one-fourth of the operations performed lasting one hour and fifteen minutes required a supplementary anæsthetic, whereas over two-thirds of the operations lasting one hour and thirty minutes required a supplementary anæsthetic

There was only one death in the group (0.2 per cent) which seemed to be due directly to the anæsthetic but there was a group of eighteen cases in which it seemed fairly reasonable to assume that the anæsthetic contributed (3.0 per cent) The average blood-pressure drop in this group was 82/50 The mortality rate for the patients between forty and fifty years of age was 8.45 per cent whereas in the next decade the rate jumped to 25.4 per cent

## SPINAL ANÆSTHESIA

Chart 2 simply shows the distribution of cases from the standpoint of operative procedures performed under spinal anæsthesia. Over one-fourth

Chart 2		DISTRIBUTION OF CASES	
Intra-abdominal Operations		690	Extra-abdominal Operations 310
Biliary Tract	186		Hernia 111
Biliary Tract <sup>Combined with GI</sup>	97		Amputation 38
(Cholecystectomies 113)	283		Hemorrhoid 37
Stomach	32		Fistula 19
Intestine	132		Prostate 14
Appendix	153		Kidney 8
(Appendectomy 127)			Miscellaneous 83
Gynecological <sup>Combined with GI Ops</sup>	15		
Celiotomies <sup>(Explorations and Biopsies)</sup>	37		
Genito-Urinary	3		
Miscellaneous	35		
(Splenelectomies 12)			
115 Different Procedures		49 Different Procedures	

Chart 3		COMPLICATIONS AND INCIDENTS	
		DURING ANAESTHESIA	
		(596 Cases)	
Intra abdominal Operations	Severe	Extra abdominal Operations	Severe
Nausea	176 (42%) 30	38 (37%) 2	
Vomiting	114 (27%) 13	28 (27%) 1	
Restlessness	37 (8%) 11	12 (11%) 1	
Weak Irregular or Rapid Pulse	35 (8%)	10 (9%)	
Syncope	30 (7%) 7	6 (5%)	
		Others -	
		Difficulty Breathing	8
		Shallow Respirations	6
		Rapid Respirations	3
		Pressure in Chest	2
		Pain in Chest	3
		Constriction around Chest	1
		Difficulty Swallowing	1
		Pain in Shoulder	1
		"Cramps in Stomach"	1
		Pressure in Abdomen	1
		Headache	2
		Sensations in legs	1
		Diaphoresis	2
		Frankly Uncooperative	1

of the entire group consisted of biliary tract or biliary tract and gastro-intestinal tract operations combined

Chart 3 shows the complications and incidents which occurred during

the *course* of operation The total incidence of nausea and vomiting, restlessness, pulse irregularities and syncope did not vary much between the intra-abdominal and the extra-abdominal groups except that in the former the severity of symptoms in general was more marked

In the more recent group of 100 cases in which larger doses of anæsthetic drug, ephedrine, and sedative were used, it was found that there was a gain of only about fifteen minutes of anæsthesia by increasing the dose of novocaine from 120 to 300 milligrams The average drop in blood-pressure was almost nil (11/6 as contrasted with the average for the foregoing group of 48/28) There was *almost* always a *rise* in the blood-pressure under the newer technic The number of failures was about the same (4 per cent) The gross incidence of deaths was lower (8 per cent) as was the incidence of pneumonia (3 per cent—all terminal) The incidence of other post-operative complications was also lower

The post-operative complications and sequelæ thought to be due to the spinal anæsthesia were also reported

(1) One case of diplopia due to paralysis of the left lateral rectus muscle which persisted for two months

(2) One case of injury to nerve roots Lumbar III, VI, V, Sacral I, II, III (partial) resulting in radiculitis and causing weakness of one leg with subsequent almost intractable trophic ulceration of the ball of the great toe

There were no broken needles and no local or meningeal infections

# BRIEF COMMUNICATION

## MECKEL'S DIVERTICULUM PERFORATION BY A FISHBONE

THE perforation of the diverticulum of Meckel by a fishbone produces a serious surgical condition which is fortunately extremely rare. I have been able to find but five cases reported. Blanc<sup>1</sup> reported the case of a forty-one-year-old man operated upon in 1898. Symptoms were of ten days' duration and the patient was observed for an additional five days and then operated upon. A hard fibrous mass was found which proved to be a Meckel's diverticulum with a fishbone in its wall. Recovery was uneventful. Piquand and Gienet,<sup>2</sup> in 1900, reported an autopsy on a woman of forty-five years with symptoms of over one year's duration. A Meckel's diverticulum perforated by a fishbone was found. Hagler and Stewart,<sup>3</sup> in 1920, report the case of a man of thirty-nine years with symptoms of two days' duration with death from peritonitis six days after operation. A Meckel's diverticulum perforated by a fishbone was surrounded by an omental mass. Walking,<sup>4</sup> in 1931, reported the case of a boy of eight years who upon operation was found to have an abscess in the abdominal cavity with a Meckel's diverticulum in its center perforated by a fishbone. Recovery resulted. Wilcox,<sup>5</sup> in 1932, operated upon a seventy-one-year-old man who had symptoms of forty-eight hours' duration resembling appendicitis. After eleven hours' observation operation revealed a broad-based Meckel's diverticulum with a fishbone protruding for one-fourth of an inch. The fishbone was withdrawn and the diverticulum inverted by the purse-string method and recovery followed. Wilcox's patient had had two previous laparotomies by other surgeons.

The case reported here is that of a girl fifteen years of age first seen at eight o'clock in the evening of Tuesday, June 24, 1930, with pain in the right lower quadrant of the abdomen which was cramplike and very severe. She had eaten fish on Sunday and Monday. At two o'clock P. M., six hours previously, while riding in an auto she began to have pains in the lower abdomen on the right side and the severity gradually increased until at the end of six hours the pains were very severe and the writer was called to see her.

Her past history was unimportant. There was no previous history of gastrointestinal disturbance. She had had pyelitis four years previously.

The general physical examination was that of a well-developed girl who was entirely normal except for the abdomen. There was marked tenderness in the right lower quadrant extending well down toward the pelvis. There was marked rigidity throughout this tender area but no distension. The temperature was 100°, pulse 72 and respirations 20. The white blood count was 13,700 and the differential showed 69 per cent polymorphonuclears, 29 per cent small lymphocytes and 2 per cent large mononuclears. The urine was normal.

Operation was performed at Northwestern Hospital about nine hours after the onset of symptoms. On opening the peritoneum the small intestine which presented was found to be inflamed, and on searching for the appendix turbid fluid was found in the right lower quadrant and also in the pelvis. The fluid was not walled off. The appendix was readily found and delivered and was moderately long and showed evidence of a

## BRIEF COMMUNICATION

previous inflammation but was not acutely inflamed at the time. The appendix was removed. A search was made for the cause of the peritonitis and the patient was placed in Trendelenburg position after aspirating the fluid and the pelvic organs were examined visually. At the same time, about the level of the brim of the pelvis there was an object which appeared to be about one-half inch of No. 1 catgut lying on the surface of one of the loops of intestines. On closer examination it was found that this was lying on a Meckel's diverticulum which was only slightly inflamed near its tip. The Meckel's diverticulum was about the size of the thumb of an ordinary rubber glove and the object on the diverticulum was a fishbone which had penetrated the diverticulum about one-half inch from its tip with the sharp end sticking out and the larger end of the fishbone still within the lumen of the diverticulum, thus permitting a constant escape of the intestinal contents (Fig. 1). The diverticulum was ligated and removed and the stump inverted with a double row of Lembert catgut suture. A penrose drain was placed in the pouch of Douglas and brought out at the lower angle of the wound.

Convalescence was quite uneventful. The maximum temperature was  $101^{\circ}$ , pulse 108 and respirations 24. The drain was completely removed June 29, five days after operation.

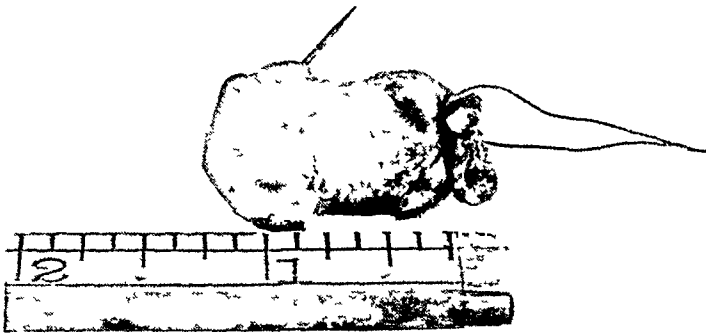


FIG. 1.—Meckel's diverticulum perforated by a fishbone

The perforation of Meckel's diverticulum by a fishbone is of such extreme rarity that this report of six cases might be considered as of greater interest to a mathematician than a surgeon. On the other hand, it is hoped that this report may help the surgeon to keep this interesting anomaly in mind when examining the abdomen. In the case here reported, failure to search for the Meckel's diverticulum combined with any condition which would have obscured the perforating fishbone might well have resulted in failure to diagnose the cause of the peritonitis.

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## ANNULAR GASTRECTOMY

FURTHER OBSERVATIONS ON THE CAUSE OF ITS FAILURE

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THE purpose of this report is not to recommend the annular or sleeve resection of the stomach but rather to set down certain technical factors that have entered into the cause of its failure. The literature ascribes stricture as the cause, but, inasmuch as cicatricial narrowing has not been the experience of all, there must be certain operative incidents present in the performance of the resection at one time that are not present at another time. It seems probable that if the clinical instances of outstanding failure be critically studied and checked up against properly controlled experimental technics some findings of clinical value should be forthcoming.

It is understood that constitutional factors must necessarily enter into the healing process of each individual's tissues and must constitute a variable which of themselves may account for healing to be rapid in one patient and retarded in another. These include congenital or inherited tendencies in wound repair, sympathetic nerve and glandular secretory influences upon the circulation and neuromuscular activity of the stomach, toxæmias, systemic infections, organic disease, and malignancy. The increased mortality of operations in diabetics, cardinals, and carcinomatous patients compared with similar operations in strong adults with chronic ulcer is generally known. One must depend upon the elimination of patients in whom these factors make too bad risks for operation by the processes of careful history taking, physical and laboratory examinations, and by medical consultations.

Annular resection has not been performed in over a decade upon the third division at Bellevue Hospital. In the original six operations performed by the author no strikingly unfavorable technical results were observed. One of these came up for secondary operation for a new growth at the pylorus and although the gastro-gastriostomy wound was so smooth as to be imperceptible, the occurrence of malignant disease in the remaining pyloric portion very strongly argued in favor of a subtotal resection for the primary operation. It was observed in these and others of the same period that the early convalescence was remarkably natural so that it was possible in an asthenic patient with a post-operative pneumonia to commence rather energetic gastric feedings with toleration by the patient within the second week. The leaving in of the pyloric end, besides constituting in itself a possible site for ulcer or new growth, interferes with the normal inter-

change of duodenal secretions This remnant is cut off from the coordinating influences of the gastric vagi through transection of the stomach and develops an intrinsic hypermotility which acts as a barrier to regurgitation of alkaline secretions The post-operative acidities remain little changed In this experience it has been this pyloric remnant with its interference with the alkalinization of the stomach and the dangers of recurrent ulcer or new growth that have militated most against the wisdom of using this operation

The local technical factors which pertain as well to a gastroenterostomy suture line have been considered to be vasoligation and its restriction of the regional blood supply, suture tension and its further reduction of the remaining circulation after necessary ligations of bleeders, and contamination

The stomach is generally recognized as a vascular organ Beinheim<sup>1</sup> in attempting to produce necrosis and ulcer by devascularizing the stomach concludes "The stomach (of the dog) can withstand any amount of diminution of its blood supply, whether on the lesser or greater curvature, or on both, short of total devascularization Collateral circulation must be not only most extensive but most active and effective Ligation of blood-vessels does not give rise to ulcers" Similarly, one of our own group had performed a series of regional vascular ligations about wounds in canine stomachs and noted the effects upon healing J Mulholland repeated experimentally what is done in a limited way clinically that of picking up bleeding vessels a short distance back from the cut edge of the gastroenterostomy stoma and ligating them, except that he ligated a series of vessels entirely about the stoma Mulholland's results appear in the following table

TABLE I

*Table Showing Influence of Vasoligation 2.5 Centimetres from Suture Line upon Resulting Size of Stoma*

	Date of Operation	Time in Days	Stricture
Dog No 1	11/16/28	157	0
Dog No 2	11/21/28	145	1 +
Dog No 3	11/23/28	27	1 +
Dog No 4	12/6/28	16	3 +
Dog No 5	12/8/28	40	0
Dog No 6	1/31/29	39	0
Dog No 7	3/7/29	59	2 +
Dog No 8	4/4/29	21	2 +
Dog No 9	4/11/29	7	3 +
Dog No 10	4/13/29	40	0

From the above it appears that stricture to some degree follows in 60 per cent and no stricture in 40 per cent

From these observations it is evident that the marked vascularity of the normal stomach is ample to provide for the healing of a stoma under ordinary conditions but that it is possible to carry ligations so far as to cause the development of stricture

A similar situation arises in respect to the gastro-gastrostomy wound in annular gastrectomy In this technic several vessels are necessarily ligated

## ANNULAR GASTRECTOMY FAILURES

In this manner it may be assumed that practically the same amount of blood will be removed from the healing wound by a number of operators. It is not conceivable, however, that many operators will exert the same degree of tension on the sutures. Still it is this element in the individual operator's technic that determines the net amount of blood flow to the granulating and epithelializing wound. This factor, tautness of the suture, may therefore account for the variable results obtained by various operators in the performance of the operation.

To observe the effects of taut suturing, stomachs were divided each into two transverse planes and resutured using a taut shoemaker's stitch in an anastomosis and a Connell and Cushing-Lembert gently drawn so as to leave

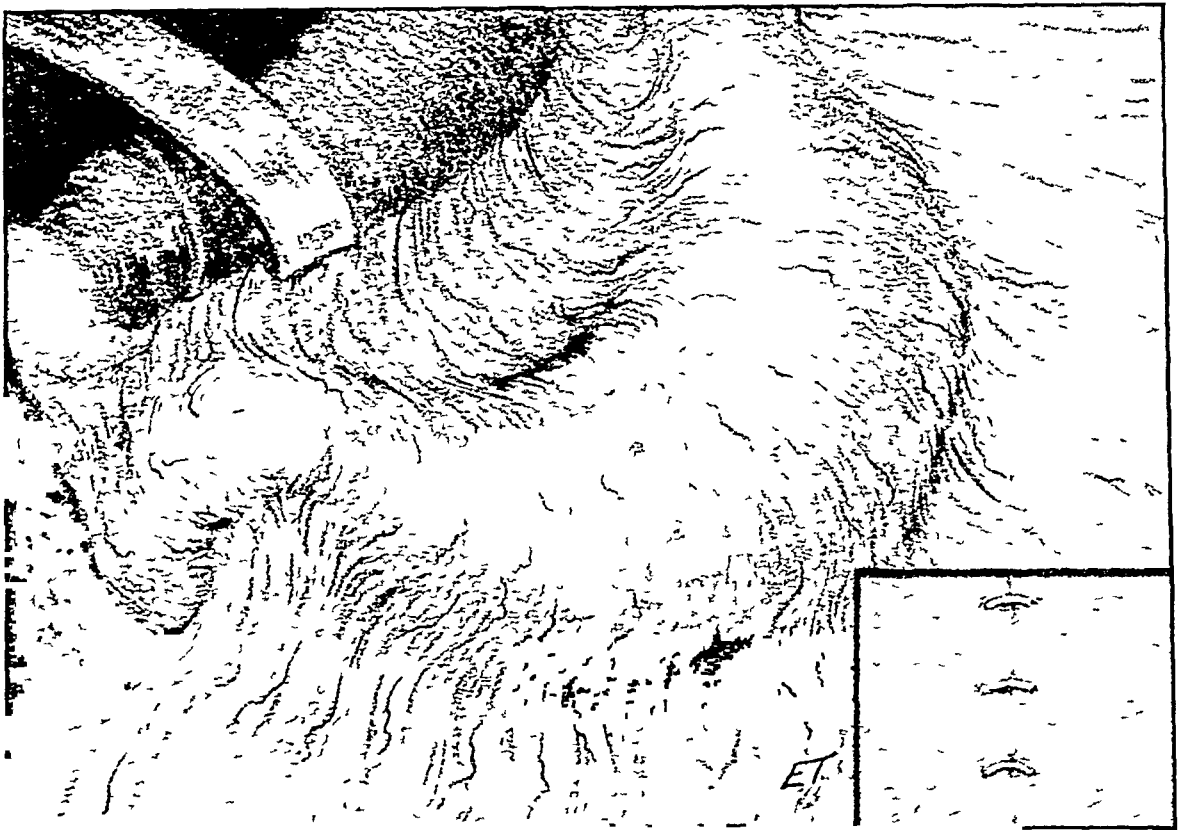


FIG 1—Drawing of gastro-gastrostomy with properly inserted sutures, indicating normal size relations of oral and aboral portions of stomach. (Insert indicates vascular changes about and between sutures drawn with proper degree of tension in the course of gastro-gastrostomy.)

a faint pink suture line in the remaining anastomosis in each stomach (Figs 1 and 2). In these experiments, tautness was exaggerated to emphasize the pathological changes. Ischaemia was followed by distortion of the suture line and fibrosis or perforation. This problem was duplicated by Dr H Behrens while a graduate student at the University upon the author's suggestion. He performed eight gastro-gastrostomies, one on each experimental animal. The sutures were inserted to "approximate" tissues in two. In these the stomata were found free from stricture after three weeks. In three animals after a suture "drawn tightly" in twenty-eight, four, and ninety days respectively, the stomata were "slightly contracted," free from stricture, and "markedly" strictured. After five, twenty-one, and three days respectively, "very tightly drawn" suture lines were found "necrotic," "extremely



strictured," and "necrotic " Behrens" conclusions were "Very tight sutures strangulate and lead to various degrees of necrosis including ulceration Moderately tight sutures lead to stricture Sutures inserted to approximate the serous surfaces favor healing of the suture line with a minimum of scar tissue or stricture formation "

Subsequently two more post-graduate students, Drs S Mufson and S M Rabson, using twenty dogs, endeavored to determine what amount of stricture followed annular resection Resections of segments of 10 to 30 centimetres at the lesser curvatures and 15 to 70 centimetres on the greater curvatures were excised from the midgastric portions of five dogs, from the junctions of the middle and lower thirds in seven, and from prepyloric

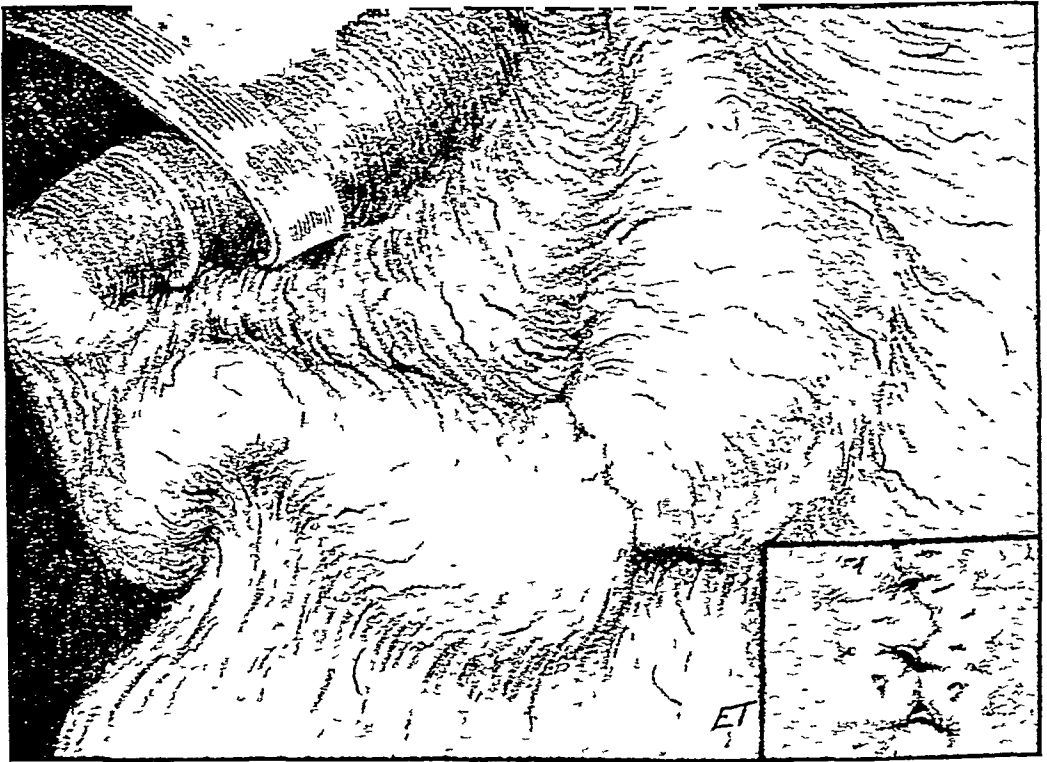


FIG 2—Drawing indicating strictured anastomosis between oral and aboral portions of stomach following tightly drawn sutures (Insert indicates vascular changes about and between strangulatory sutures )

portions in eight dogs Of these twenty animals, there were fourteen properly sutured gastro-gastrostomies and six taut anastomoses The mean duration of life of the former group was thirty days and of the latter ten days There were two deaths from leakage at the suture lines in the group of fourteen "properly ' sutured animals and four from leakage at one or other curvatures, more often at the greater in the tautly sutured group Histologically they report moderate cellular reaction except about the sutures where dense infiltration was noted as late as 153 days Marked cellular infiltration and necrosis were observed in the perforated animals Mufson and Rabson conclude "All dogs in which sutures were tautly drawn died within

## ANNULAR GASTRECTOMY FAILURES

ten days from perforation or hæmorrhage. Taut sutures invariably led to necrosis so that in this series it was impossible to study fibroid changes in late suture lines. The properly sutured normal animals that survived several months showed roentgenographically no evidence of biloculation or of impaired motility and on necropsy no evidence of 'hour-glass' deformity other than projecting edges at suture lines."

These findings agree with those of Stewart<sup>2</sup> and Barber<sup>3</sup> in earlier papers. It is noteworthy that in those instances in which gangrene developed during the course of healing after gastro-gastrostomy it more often appeared at the greater curvature. This corresponds with the experimental findings of Bernheim and also with the pathological changes reported in occasional clinical failures.

Another factor to be considered in all operative technics is contamination. This factor was purposely combined with that of suture tension in a large series of experimental wounds by Doctors S. Davidson and J. R. Murphy during the past year. The results may be tabulated as follows:

TABLE II

*Tissue Reactions to Taut and Contaminated Sutures in Wall of Canine Stomach*

	Hæmorrhage			Leucocytes			Fibroblasts			Necrosis		
	T	L	C	T	L	C	T	L	N	T	L	C
Mucosa				x		x	x?	x?				
Submucosa	xx		x	xxx	x	xx	x?	x?		x	x	x
Muscularis	x	x		xxx	x	x	x?	x?				
Serosa	xx	x	x	x	x	x	x?	x?		x		

"T" refers to suture drawn more tightly than normally, "L" indicates normally tense suture, and "C" suture moistened in gastric secretion, "x" denotes degree of hæmorrhage, number of leucocytes, etc. All experiments were terminated by euthanasia.

Their conclusions were: "The only definite findings which can be drawn from the above is that fibroblasts appear sooner and fibrous tissue was longer observed in the clean than in the contaminated sutures." The taut suture stimulated an early outflow of leucocytes, more than either "contamination" or the "loose" suture. Some of these white cells may have come into the outer layers of the gastric wall in the hæmorrhage (noted more commonly after the tight suture in the above table). Abscess and necrosis were not outstanding after taut, "loose," or contaminated sutures in the hands of the above investigators.

From these several observations on normal stomachs by various investigators, it seems probable that the stricture often reported as the essential cause of failure after mesogastric resection is partly due to the requirements of the operation itself, which compel ligation of both curvature vessels and multiple ligations of mural branches, but also to overtaut sutures in the anastomotic line that further reduce the blood supply to the healing gastro-gastrostomy wound.

In abnormal stomachs in pathological individuals with impaired circulation or with poor neuromuscular tone as is often met with in carcinomatous patients necrosis may prevail in the absence of a firm replacement fibrosis and go on to perforation (Figs 3 and 4)

The post-mortem drawings (Figs 3 and 4) refer to a young adult male with carcinoma of the stomach and upon whom a Polya resection was performed. He reacted naturally until the seventh post-operative day when he developed a rise in temperature, distention,\* and discharge from the wound (beginning peritonitis) and nephritis. His blood-pressure, low throughout, reacted to transfusion but never rose above 100 systolic

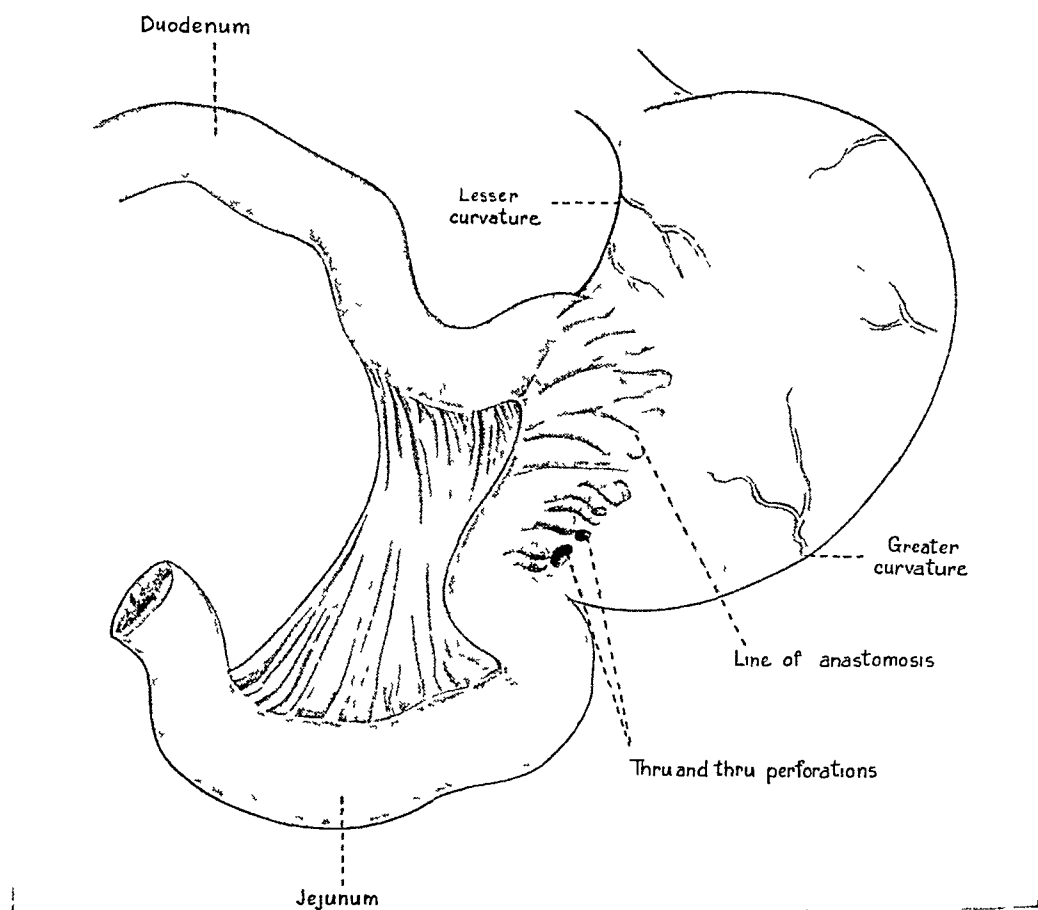


FIG 3

while leucopenia persisted. Of special significance are the necropsy findings ten days after operation which besides organic disease in the lungs, liver, and kidneys were "Section through gastrojejunal junction shows oedema of the muscularis and foci of lymphocytic infiltration. In deeper layers of muscularis there are foci of necrotic material containing much nuclear debris. In one of these foci a bit of highly refractile material suggestive of catgut is seen. Serosa is covered by several layers of fibrin. Gastric mucosa shows superficial erosion and oedema of glands, many of which are desquamated. Same on the jejunal side. Another section through the gastrojejunal margin shows superficial erosion, focal necrosis in the mucosa, oedema in muscularis, and acute fibrinous exudate over the serosal surface. *Diagnosis*—Necrosis at the gastrojejunal anastomosis

\* The author desires to call attention to the frequent absence of the usual signs of tenderness and rigidity in acute peritonitis in patients of extremely lowered resistance

## ANNULAR GASTRECTOMY FAILURES

The anastomosis held for the first week There was fibrinous exudate but no new connective tissue Necrosis terminated fatally

From this experience with the normal and pathological stomachs the following precautions stand out

(1) Ligate bleeders in the cut edges of the wound rather than at a distance from the line of incision

(2) Draw in sutures so as to approximate rather than so as to distort or blanch the tissue

(3) In patients of doubtful operability take the greatest possible ad-

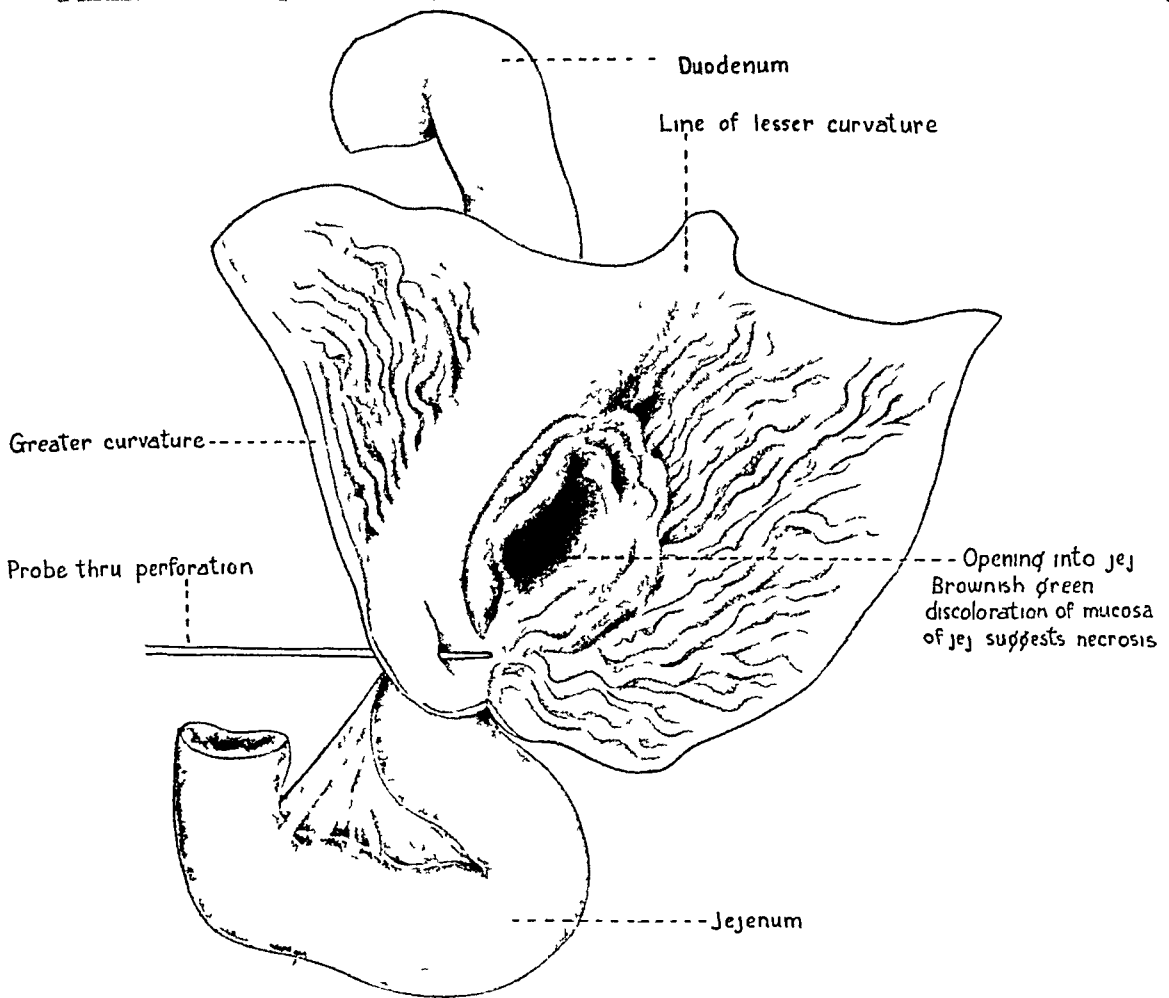


FIG 4

vantage of the adhesive inflammation destined to appear on the serosal surfaces of the wound by the application of omental or peritoneal grafts

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# TUMORS OF THE STOMACH\*†

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THE most common tumor of the stomach is carcinoma. A larger proportion of carcinomas occur here than in any other organ of the body, and gastric carcinoma affects three times as many men as women. Carcinoma of the stomach, as is true of carcinoma in most other regions, is curable in its early stages and hopeless when it has progressed so that the neoplasm cannot be removed, control of the disease rests primarily on its early recognition so that surgical removal can be accomplished. The disease appears in persons between the ages of forty and sixty-nine years in 85 per cent of the cases. The symptoms, signs, and course of the disease are dependent, in large measure, on the situation, extent, and rigidity of the growth. In certain situations in the stomach, namely, in the upper and middle portions, carcinoma may appear and develop, producing few symptoms, whereas growths that interfere with emptying the stomach give rise to marked disturbance even in their early stages.

In general, the most important and most frequently occurring symptom is persistent, dyspeptic discomfort. In some cases symptoms suggestive of an ulcer may have been present over a period of years, later to assume malignant characteristics, such as failure of the patient to obtain relief from pain by methods which previously had been effectual. There is a relatively small group of patients who have had indigestion of an irregular nature, sometimes the result of a diseased appendix or gall-bladder, with mild symptoms, and the change to symptoms characteristic of carcinoma is so insidious that the patient is without knowledge of the change.

Carcinoma of the stomach can be detected by a competent rontgenologist in 95 per cent of cases. It should be emphasized that rontgenological examination of the stomachs of patients forty years of age or more, who have indeterminate dyspepsia, is the most important procedure in examination, and should never be omitted in any suspicious case.

Two cases which recently came under my observation have emphasized the value of the rontgenological examination in cases of early carcinomatous lesions. In the first case, the presence of a small, carcinomatous, ulcerating lesion, 1.9 by 1.7 centimetres, was detected by the rontgenologist, found and removed by the surgeon, and the pathologist confirmed the diagnosis of malignancy. In the second case, that of a man aged thirty-two years, the rontgenologist had made a pre-operative diagnosis of small, ulcerating malig-

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nant lesion of the lesser curvature of the stomach. At operation, with the lesion between my exploring fingers, I felt that it was inflammatory. The distal half of the stomach and the first portion of the duodenum were removed, nevertheless, because of the uncertainty of the nature of the lesion, and the pathologist reported it to be an adeno-carcinoma, graded 2.

The difficulty and importance of diagnosis of a malignant lesion of the stomach has been well stated by Balfour: "There is no characteristic syndrome of carcinoma of the stomach. Although there is a more or less constant syndrome in the average case, there are so many exceptions to the rule that the astute clinician will, by keen recognition of this fact, establish a diagnosis of the disease at a time when the symptoms are bizarre and when surgery can offer some prospect of cure."

*Types of malignant gastric lesions*—Ulcerating adeno-carcinoma of the stomach is of most frequent occurrence. The lesion tends to be more painful than other types and blood oozes from it more freely. Large tumors of the stomach are usually of the colloid type, the lesions are sharply demarcated, and thus readily lend themselves to removal by extensive resection of the stomach. This should emphasize the point that it is not the size of the lesion, but its mobility and extent, which determines whether it can be removed. The scirrhus type of lesion is frequently localized at the antrum of the stomach, producing symptoms by obstruction, whereas the linitis plastica type, with involvement of the entire stomach, may exist with but few symptoms until late in its progress. Sarcoma of the stomach occurred in the proportion of one sarcoma to 159 carcinomas in the years 1908 to 1920 at The Mayo Clinic, as reported by Masson. It might be said in general that sarcoma of the stomach occurs earlier in life than carcinoma. In a study of fifty-four cases of sarcoma of the stomach seen at the Clinic from 1908 to 1929, Balfour and McCann found that in all but one case the patient had come to operation. The majority of the lesions were diagnosed as carcinomas of the stomach before operation, and the lesions were removed surgically in thirty-six of the cases.

*Surgical Treatment*—It has been the custom at the Clinic to advise abdominal exploration in all cases of carcinoma of the stomach, unless unre-movable metastatic growths have been proved to exist. The rationale of such a decision rests on the basis that occasionally roentgenograms will give evidence that a lesion is of greater extent than it really is, and frequently the stomach is found to be unusually movable, a circumstance that makes any localized gastric carcinoma suitable for removal.

Occasionally the presence of a benign tumor of the stomach, such as a benign polyp or foreign body, may produce a large defect in the filling of the stomach, leading to an erroneous opinion as to the type and extent of the lesion. In an occasional case a badly diseased and distended gall-bladder or distension of the splenic flexure of the colon from gas, or the presence of other lesions in adjacent viscera, may so interfere with the neuromuscular activity of the stomach that apparent defects in outline suggestive of carci-

noma manifest themselves When such disturbances involve the upper portion of the stomach, they may lead to the erroneous interpretation that the lesion is inoperable

In the last few years, I believe we have been able to remove an increasing number of extensive malignant lesions of the stomach This has been partially due to the fact that a patient is never denied the benefits of removal of a malignant gastric lesion if it is possible to remove it In the last three years total gastrectomy has been performed at The Mayo Clinic in seven cases It is interesting that three of the seven patients are living and well, more than a year since operation, one, almost two and a half years since operation, another two years since operation, and another more than a year since operation That such an operative procedure could be carried out in suitable cases, with great benefit to the patient, has led to the impression that gastric lesions, therefore, should be removable unless they have invaded adjacent structures and thus could not be removed in their entirety

In many instances in which the lesion at first would appear to be incapable of removal, because of extent of the growth and attachment to the mesocolon or capsule of the pancreas or liver, it is found after the freeing of adhesions, and separation of the lesion from these structures, that the growth is readily removable In other cases, particularly if the tumor is large, the uninvolved portion of the stomach may be thickened and give the appearance of involvement, although thickening may be only the result of gastritis adjacent to the lesion Finally, it is not an uncommon experience to find that a growth examined while the patient is straining under light anæsthesia appears unremovable, but under deep anæsthesia it may appear to be readily removable

In general, the statement can be made that approximately half of the patients who are in suitable condition for exploration for malignant lesions of the stomach, will be found to have operable lesions

*The Curability of Carcinoma of the Stomach*—In the symposium on carcinoma presented at the Clinical Congress of the American College of Surgeons in New York last year, Balfour reported a group of 278 patients who had lived for five years or more following removal of carcinomas of the stomach, stating that five-year cures could be obtained in 50 per cent of the cases in which the lymph-nodes were not involved This statement should not be construed, however, to mean that the presence of involved lymph-nodes is a contra-indication for operation, in many of the 278 cases there was involvement of lymph-nodes

It should be remembered that enlargement of lymph-nodes along the curvatures of the stomach does not necessarily mean involvement by carcinoma, for microscopical examination of many of these enlarged nodes will show them to be inflammatory and to contain no cells of carcinoma In either event, complete removal of all enlarged nodes in the gastrohepatic omentum, along the lesser curvature of the stomach, as well as those along the greater curvature of the stomach at the time resection is done, is the advisable procedure

*Palliative Treatment of Inoperable Malignant Gastric Lesions*—In discussing the treatment of carcinoma of the breast, and its recurrence, Handley stressed the point that we must not be content to treat only the operable or curable cases of malignant disease but that any procedure which can be carried out for the patient with a recurring malignant lesion or an inoperable malignant lesion, which will make the remainder of the patient's life more comfortable, is our duty. No better example can be found of the value of palliative measures than in surgical treatment of inoperable carcinomas of the stomach.

Removal of a necrotic, ulcerating, bleeding lesion of the stomach, even though metastasis may be present in the liver, is a palliative procedure worthy of consideration in dealing with a patient whose general condition warrants it. Similarly, in the presence of obstruction, gastroenterostomy will not only bring relief of the distressing vomiting, but will enable the patient to take adequate nourishment, and these effects of the operation mean restoration of weight and improvement in general well-being. Mayo and Balfour have both directed attention to the fact that patients may live, two, three, and four years, in good health, following palliative removal of a malignant lesion of the stomach, even if metastasis was found at the time of the operation. This is particularly true regarding hepatic metastasis, which seldom becomes a site of infection.

In cases in which palliative resection or gastroenterostomy seems inadvisable, jejunostomy can be performed for feeding, and the patient's stomach can be kept empty subsequently by means of a stomach tube. Emphasis again should be placed on the fact that relief of symptoms and prolongation of life often can be afforded the patient with incurable carcinoma by treatment directed to these ends.

*Benign Tumors of the Stomach*—Benign tumors of the stomach, although of rare occurrence, may give rise to pyloric obstruction, due to their intermittent prolapse through the pyloric sphincter, or they may be the cause of severe gastric hæmorrhage, due to ulceration. In 1922, Eusterman and Senty reported a series of twenty-six surgical cases of benign gastric tumor, and in 1927 Balfour and Henderson added thirty-two in which operation had been performed at the Clinic up to 1927. These benign tumors consisted, for the most part, of fibro-adenomatous polyps and other tumors of the gastric walls, namely, fibromas, myxomas, fibro-adenomas, adenomyomas and myxo-fibromas. These tumors varied from one of slight weight, 5 millimetres in diameter, to one weighing 1,000 grams. This large tumor was a dermoid cyst filling the retroperitoneal cavity. In twenty-two cases the tumor was associated with other lesions, in five, with carcinoma of the stomach.

It is interesting that in all cases of gastric polyp uncomplicated by other gastric lesions, free hydrochloric acid was absent from the gastric content. This tends to obscure the differential diagnosis of gastric carcinoma, pernicious anæmia, and benign gastric tumor. The tumors are relatively symptom-



less unless the pedicles are of sufficient length to allow the tumors to prolapse through the pylorus, producing intermittent obstruction, or unless they become ulcerated and produce bleeding

The malignant potentiality of all polypoid tumors of the stomach closely parallels that of the same type of tumor occurring in the colon, therefore, the pedicle of each of these lesions should be carefully examined at the time of removal to be certain whether malignant cells are present. In one of the cases reported by Balfour, a polyp approximately 7 centimetres in diameter, situated near the cardiac end of the stomach, was suggestive of malignant degeneration. Although the tumor was rather inaccessible it was cauterized and removed at the pedicle. Four months later, exploration revealed an inoperable carcinoma of the cardiac end of the stomach, apparently originating at the site of the polyp.

From the standpoint of treatment of the lesion, transgastric excision of the tumor when benign, as was done in seventeen of the thirty-two cases, is worthy of consideration. However, in larger tumors the probabilities of malignant degeneration makes partial gastrectomy advisable.

*Present Status of Peptic Ulcer* —The present status of the surgical treatment of duodenal and gastric ulcer might be said to depend on the results which are obtained in suitable cases under a medical regimen. I have said "suitable cases," because I want to attempt, first, to eliminate from consideration those cases in which there is unanimity of opinion regarding treatment. For example, acute duodenal or gastric ulcer, which has perforated, is recognized by everyone to constitute a surgical emergency, and closure of the perforation is necessary. Whether, in addition to this, other procedures, such as gastroenterostomy or gastric resection should be done is dependent on the condition of the patient, and on what, in the experience of the operating surgeon, has given the best results at low rates of mortality in other cases of similar type.

The patient with a chronic duodenal ulcer without complications, whose symptoms are mild, neither interfering with work nor his pleasure, is best treated medically. Patients with subacute, perforating duodenal ulcers, especially those in whose stomachs evidence of a crater can be demonstrated roentgenologically, patients with bleeding duodenal ulcers, and patients with obstructing duodenal ulcers, are best treated surgically. In addition to these patients who have these complications, there are a great many with chronic duodenal ulcers whose symptoms do not respond to a medical regimen, and who welcome a surgical procedure of low risk that will afford them relief.

It might be said that in the treatment of any lesion, ulcerating or otherwise, duodenal, gastric, intestinal or vesical, direct attack on the lesion, and its removal, when such can be accomplished safely, is the advisable procedure. Unfortunately, removal of the complicated type of duodenal ulcer cannot always be accomplished safely. The obstructing duodenal ulcer is frequently adherent to the pancreas, and is surrounded with much inflammation and œdema, and its removal is carried out with a great deal of difficulty, especially

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when too small a part of the duodenum remains to permit of perfectly accurate closure after gastric and duodenal resection. The same applies to hæmorrhagic duodenal ulcer, which usually is situated low on the posterior wall of the duodenum. Such a bleeding lesion usually has perforated into the head of the pancreas, forming a craterous ulcer. That an ulcer of this type may be present, even though an ulcer is present on the anterior wall of the duodenum should be remembered. It should be suspected in every case in which there has been intestinal bleeding, even though Röntgen-rays fail to give evidence of its presence.

Typical biliary colic, occasionally with some jaundice, may result from perforating ulcers of the posterior duodenal wall. Many such patients whom I have seen had had their gall-bladders removed elsewhere, and I suspected the presence of stone in the common bile-duct, with recurrence of symptoms. Perforation of the ulcers into the pancreas was the cause of recurring attacks of pain, and the jaundice was the result of inflammatory œdema of the pancreas, obstructing the pancreatic portion of the common bile-duct. The situation of the ulcer on the posterior wall of the duodenum, and its perforation into the pancreas at a low level, without involvement or deformity of the anterior wall, had prevented its roentgenological visualization in some cases. In some of the cases the lesion had been overlooked at the time of the previous exploration, presumably because the anterior duodenal wall was not involved and the posterior wall was not palpated.

Occasionally severe, almost fatal, intestinal hæmorrhages occur from ulcers of the type just mentioned, hæmorrhages usually ceased after gastroenterostomy. I mention this particularly because many of the lesions one is most anxious to remove are of the type that can be removed only with the greatest difficulty, and with the greatest risk. We have traced such patients after gastroenterostomy, to see, with the greatest satisfaction, the symptoms of most of them disappear, and they regain their health. Furthermore, gastroenterostomy in these cases carried but little more risk than in the average case, which in our experience has been that of a mortality rate of about 1 per cent. One may contrast this mortality rate with that following removal of extensive perforating, obstructing, or hæmorrhagic duodenal ulcers, which in the hands of the most experienced surgeons is considerably greater.

The question of gastric and duodenal resection is introduced because, if one is to resect ulcerating lesions of this type in the duodenum, resection of part of the stomach usually becomes a part of the procedure. This brief consideration of the perforating, obstructing, hæmorrhagic type of duodenal ulcer emphasizes the necessity of basing one's opinion as to the best surgical procedure on knowledge of the pathology of the lesion itself, and of the alteration in physiology that results from the operative procedure.

May I say, therefore, that I am basing my opinion on the ulcerating lesions of the stomach and duodenum which we in the middle western part of the country are seeing at operation. In our experience, duodenal or gastric

ulcers are localized to either the duodenum or the stomach in 90 per cent of the cases. This is in contrast to the ulcers which my colleague, Doctor Snell, and I saw operated on in the German surgical clinics. There, in addition to the duodenal ulceration, there was marked ulcerative and hæmorrhagic inflammation of the lower part of the stomach. Consequently, when this gastritis is found to be present in association with duodenal ulcer, it would seem that the type of the lesion must be entirely different from the type we see, not only pathologically, but biologically, and removal of the ulcerating portion of the stomach and duodenum should be the operation of choice.

With the lesion localized to the duodenum, and accessible, there is no reason why excision of the lesion and provision for the stomach to empty itself completely by a properly functioning gastroenteric stoma, or by means of the opening which results from pyloroplasty, should not be followed by excellent results. When the lesion is of the obstructing, perforating, hæmorrhagic type, in which removal of the lesion would seem to be complicated because of the greater risk involved, the safest, and therefore the wisest procedure to us, seems to be usually gastroenterostomy. If it becomes necessary at a later time to remove the lesion, which very seldom is the case, it will be found that because of the relief of the obstruction afforded by the gastroenterostomy, the inflammatory œdema and fixation of the lesion has subsided to the extent that the lesion can be more easily and more safely removed.

One of the most startling effects of gastroenterostomy which I have recently witnessed, was in a patient which I operated on for relief of a subacute, perforating duodenal ulcer forming a mass 5 by 3.5 centimetres in diameter and perforating against the under-surface of the liver. As a result, the patient was in poor condition, and although the operation was performed entirely under abdominal wall block anæsthesia with procaine, bilateral pulmonary abscesses developed. These were successfully drained through the bronchoscope. Unfortunately, septic thrombosis and septicæmia then developed, from which the patient failed to recover. The post-mortem examination of the stomach and duodenum, made six weeks following the gastroenterostomy, revealed the mass about the perforated ulcer to have disappeared completely, the duodenum had disengaged itself from the liver, and gross and microscopical examination of the ulcer disclosed that it had become completely healed, except for one small area 2 millimetres in diameter, situated in the superior margin of the posterior wall, where the perforation undoubtedly had taken place. With the exception of this small area, the mucous membrane had completely closed over the ulceration.

I am convinced that patients who have lesions of the duodenum associated with lesions of the stomach are best operated on by removal of the areas of the ulceration. On the other hand, the infrequency with which such accompanying inflammations of the stomach have been present in patients operated on by me in the last eight years has led me to believe that in by far the

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majority of cases, excellent results can be expected by the conservative operations of gastroenterostomy or pyloroplasty, with later excision of the ulcer if necessary. These procedures can be carried out with minimal risk.

*Gastric Ulcer*—In considering the treatment of gastric ulcer, I should like briefly to call attention to several observations which I think worthy of emphasis.

Statistics, based on cases in which operation for gastric ulcer has been performed in various clinics in this country and abroad, would lead one to believe that from 10 to 20 per cent of gastric ulcers which seem benign are in reality small carcinomas. Whether these are ulcerating carcinomas or whether they are carcinomas developing in an ulcer is of great interest to pathologists and students of etiology, yet from the practical standpoint, the fact that an ulcerating lesion of the stomach, no matter how small, may be carcinomatous, is of extreme importance.

I have removed an ulcerating carcinoma of the stomach, about 1.5 centimetres in diameter, which when subjected to roentgenological examination, and even when palpated at the time of the operation gave none of the indications of being malignant. Microscopical examination, however, demonstrated that the lesion was carcinoma. On a few occasions attempt to treat these lesions medically was followed by apparent success, the clinical features of a benign lesion being temporarily satisfied. There was relief of pain, absence of blood in the stools, and disappearance of the niche on roentgenological examination. Later, however, return of symptoms, and reappearance of the lesion in the roentgenogram led to exploration, at which time an extensive malignant lesion was found. One patient, I recall, insisted on being treated medically, but the symptoms reappeared to a more severe degree, and ten months later the patient willingly underwent exploration. Unfortunately, the lesion was found so extensively to involve the stomach that it could not be removed.

There is no doubt that medical treatment of gastric ulcers by an internist skilled in the treatment of gastro-intestinal disease, which treatment can be controlled and carried on under his observation, and the subsequent course of the patient carefully observed, is worthy of trial for certain types of gastric ulcer, particularly the acute type of gastric ulcer afflicting a young patient. It should always be remembered, however, that the decision to treat such a person by medical measures carries great responsibility, for if the lesion is malignant by the time it is found to respond unsatisfactorily to medical treatment, sufficient time may have elapsed for it to have become unremovable. It is our custom, at the Clinic, therefore, in cases of gastric ulcer which seem suitable for medical treatment, to keep the patients in the hospital under observation for three weeks. If during this time the ulcer does not respond to treatment, surgical removal is advised. Even in cases in which excellent progress is being made under medical care, the patient is advised to return at frequent intervals for reexamination.

*Summary*—Carcinoma occurs more commonly in the stomach than in any other organ of the body. The symptom of most common occurrence

is persistent dyspeptic discomfort. Carcinoma of the stomach can be detected by a competent roentgenologist in 95 per cent of cases. Ulcerating adenocarcinoma is of most common occurrence, although large carcinomas of the stomach are usually of the colloid type. Sarcoma occurs in the stomach in proportion of one sarcoma to 159 carcinomas. Exploration for every tumor of the stomach is indicated, providing the patient's general condition permits, and unless unremovable, proved metastasis already exists. In several cases successful total gastrectomy for carcinoma has been performed at the Clinic. Balfour reported 278 cases in which the patients lived for five years or longer after surgical removal of gastric carcinomas. Palliative treatment of inoperable tumors should be directed toward relief of pain and obstruction and improvement in general condition. Removal of necrotic, ulcerating lesions is justifiable in selected cases, even in the presence of hepatic metastasis.

Benign tumors of the stomach, although of infrequent occurrence, may give rise to obstruction due to prolapse through the pylorus, or they may cause hæmorrhage, due to ulceration. A gastric polyp may be malignant, and its pedicle should be examined microscopically.

The present status of peptic ulcer might be said to depend on results obtained in suitable cases under a medical regimen. The decision for surgical treatment of duodenal ulcer should rest primarily on the nature of the lesion, and the presence or absence of accompanying gastric lesions, remembering that the safety of any operative procedure is dependent on the extent of the lesion, the condition of the patient, and the experience of the surgeon. Attention is directed to the risk of delay in the surgical treatment of gastric ulcers which do not respond to a medical regimen, and to the necessity of continual observation while carrying on medical treatment in all cases of gastric ulceration.

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# TUMORS OF THE DUODENUM

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USEFUL knowledge can be obtained through the study of a large series of adequately detailed case reports. Tumors of the duodenum occur with such infrequency that the record of all cases is quite desirable. It is because of this fact and of the special and difficult diagnostic problems and the amenability of a large percentage of these growths to treatment that we present this brief review of the literature and report of a case.

A colored woman (Case No 31—9143, Hospital No S—1145), aged forty-eight years, was admitted to St Philip Hospital July 10, 1931. Her chief complaint was a mass on the right upper thigh near the hip, and "stomach trouble." The tumor on the right thigh was first noticed in 1912. This began as "small knots" under the skin. Three masses were removed in 1918, but this operation was followed by a recurrence which had reached considerable size when removed again in 1926. A similar recurrence was removed again in 1929 and also in January, 1931. There was again a prompt return, and the mass in July, 1931, was as large as a small coconut.

The onset of abdominal distress dated to three months prior to admission. The pain was gradual in onset and of a dull, aching character. There was a constant sensation of gastric fullness and vomiting occurred frequently, especially after eating heavy foods. No blood has ever been noted in the vomitus. Soft and liquid foods could be tolerated. The pain had occurred intermittently since its onset but had grown more severe and more frequent one month prior to admission. At this time the attacks were occurring in frequent colicky paroxysms lasting twenty to thirty minutes. During the attacks a swelling would form in the upper abdomen which would disappear after pain subsided. She was not relieved by food, but was occasionally relieved by change in position and vomiting. She had lost forty pounds of weight.

*The chief physical findings were* emaciation, anæmia, slightly enlarged liver, an illusive palpable mass in the right upper quadrant felt only at times when the patient lay on her left side, a multilobular mass about the size of an adult fist on the external aspect of the right thigh infiltrating the skin and surrounding tissues, but not tender.

*Laboratory Examination*—Hæmoglobin, 30 per cent (Sahli), Wassermann, negative. The remainder of the examination was negative.

The woman was operated upon first for the removal of a tumor in the upper part of the thigh. Pathological examination showed it to be sarcoma. The pathological report by Dr Pauline Williams is as follows:

*Gross Description*—Specimen consists of nodular mass weighing 300 grams. It has been cut into. It measures ten by eight by six centimetres. One portion is covered by skin. The nodules vary in size from one centimetre to five centimetres in diameter. Most are circumscribed and some are encapsulated, elsewhere two and three merge together, and are enclosed in a thin membranous capsule. They vary in consistency from very firm to fairly soft tumors, the softer ones being pale and pinkish in color, the firm ones almost white, cut surface smooth and glistening.

*Microscopical Description* (Fig 4A)—Broad bundles, longitudinal, cross-section

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and oblique, composed of fusiform cells, constitute the essential structure of these tumors. The cells are rather uniform in shape and size, having vesicular nuclei and showing rather frequent mitoses. A fine intercellular reticulum composes the stroma, blood-vessels are not very abundant. A connective-tissue capsule envelops these growths, overlying one of which is thin skin.

*Pathological Diagnosis*—Fibrosarcoma, relatively non-malignant.

A few days after removal of the mass on the right thigh, she was submitted to the X-ray department for gastro-intestinal study.

X-ray examination (Fig 1) showed a dilated and atonic stomach with a considerable six-hour gastric residue. The duodenal bulb was markedly dilated. In the erect position the duodenal bulb was never filled out and there was a large, central, translucent filling



FIG 1—Röntgenogram in right oblique position, showing multilocular defect in bulb, with trabeculations. The general contour of the bulb is preserved.

defect with the periphery faintly outlined by a thin shell of barium. The cap did not fill out completely in the prone position and showed a large, constant deformity that varied from an irregular circular, or oval, to a multilocular one. The deformity was translucent, always outlined by the thin barium shell, and traversed by trabeculations. The defect was shown in the erect, right oblique, prone and supine positions. There was no evidence of duodenal constriction. The impression from the examination was that the deformity was produced by extrinsic pathology, probably a tumor in the region of the pancreas. The possibility of a duodenal tumor was considered, but on account of the great rarity of this, was considered as improbable. (E. L. S.)

About ten days following removal of the tumor from the thigh, the abdominal operation was performed.

The stomach was found greatly dilated, the first four inches of the duodenum was at



least three times its normal size, approximately two and one-half or three inches in diameter. There was felt within the lumen of the duodenum a hard tumor about the size of a hen's egg (Fig 2). There were no adhesions or evidences of liver, gall-bladder or other abdominal disease, and it was decided to remove the pyloric portion of the stomach and the first three inches of the duodenum. This was easily accomplished, and an end-to-end anastomosis of the stomach and duodenum was made. The patient's condition was good for three days, taking liquid food, died rather suddenly on the third day with greatly dilated stomach.

A limited examination through the operative incision was made. The stomach was greatly distended, filling almost the entire abdominal cavity, the quantity of fluid within it could not be measured. The stomach had to be opened and the fluid evacuated before the examination of the site of operation could be made. We could not see any evidence of disease in other abdominal organs.

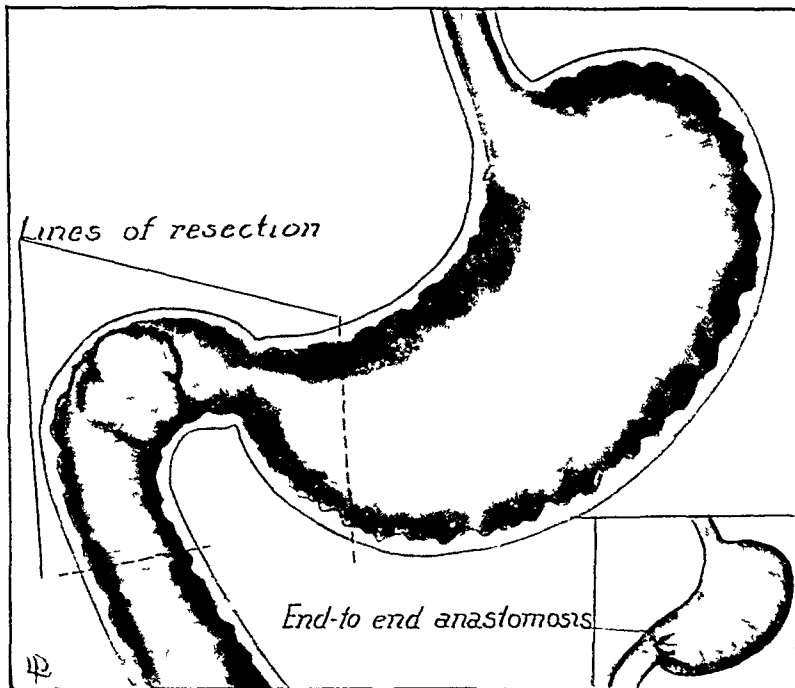


FIG 2—Diagram showing location of sarcoma of the duodenum and line of resection. Insert shows end to end anastomosis of stomach and duodenum.

The site of anastomosis was removed intact, and submitted to Dr Lewis C Pusch, who found that the healing was proceeding normally, the lumen at the site of anastomosis admitted two fingers easily, there was no area of leakage, nor evidence of pancreatic disease. The cause of death was acute dilatation of the stomach (LaR).

Report of the examination of the tumor by Doctor Pusch was as follows:

*Gross Description*—The specimen, 10 by 8 by 5½ centimetres consists of four centimetres of the pylorus of the stomach continuous with six centimetres of the duodenum (Fig 3). It is received opened longitudinally revealing a firm, nodular, pinkish-white mass, 5½ by 5 by 3½ centimetres, having a circumference of eight centimetres, attached by a potential pedicle two centimetres in diameter to the mucosal surface of the duodenum, encroaching upon the pyloric orifice. The base and adjacent duodenal wall are not indurated. The serosal surface of the specimen opposite the base of the tumor presents a dimple-like depression two centimetres long. The surface of the mass resembles that of adjacent gastric and duodenal mucosæ, it is pinkish-white, not ulcerated, granular, or friable. Lymph-nodes are nowhere recognizable.

## TUMORS OF THE DUODENUM

*Microscopical Description* (Fig 5B) —The 5½-centimetre mass is composed essentially of fusiform connective-tissue cells, moderately anaplastic. Some areas are predominantly fibrillar, suggesting the classification of fibrosarcoma, while others are densely cellular with ovoid vesicular nuclei. A few mitotic figures are seen. An invasive tendency is manifest. The tumor is not encapsulated.

*Pathological Diagnosis* —Spindle-cell sarcoma

### DISCUSSION AND REVIEW OF LITERATURE

This study is limited to benign tumors and sarcoma of the duodenum. Carcinoma, ulcer, and diverticulum of the duodenum and tumors of all kinds in the small and large intestines and stomach are excluded. The text

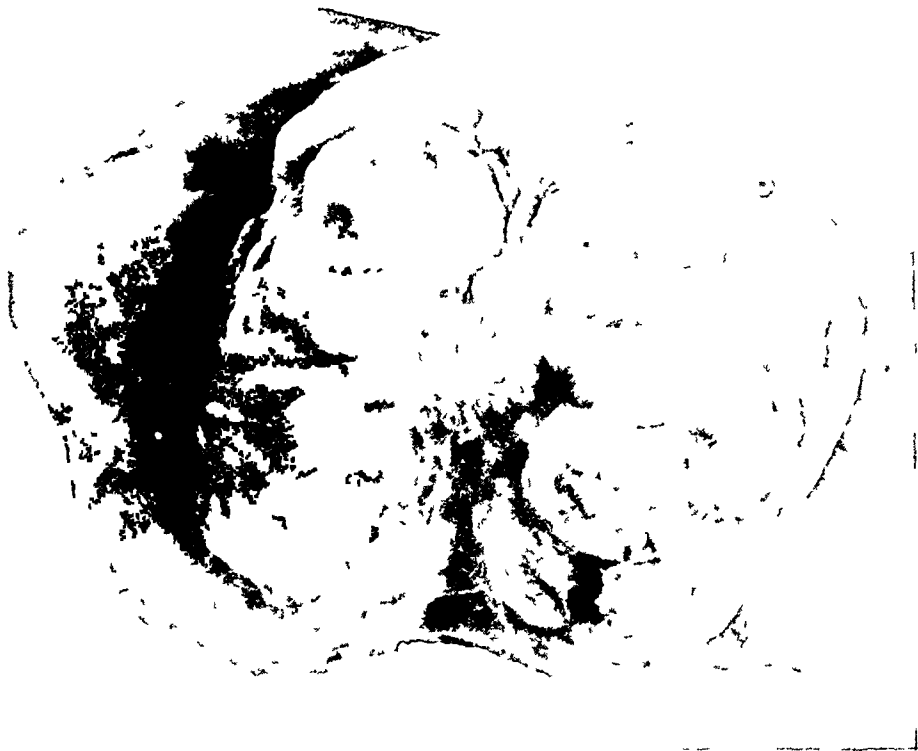


FIG 3 —Photograph of sarcoma of the duodenum

of this paper is a case of large-sized sarcoma of the duodenum, metastatic from a sarcoma of identical type, located on the thigh. Details of three other cases of sarcoma and thirty-two cases of benign tumor of the duodenum have been collected from literature.

Formerly, tumors of the duodenum were encountered at the autopsy table and in dissecting rooms as interesting rarities. Within the last ten or fifteen years, as the result of better means of diagnosis, and the large amount of surgery being done upon the upper abdominal organs, we are acquiring familiarity with the disease.

Within the past ten years, the diagnoses have been verified by pathological examination, in fifteen cases of benign tumors and three cases of sarcoma.

Within the same period of time, X-ray has been brought to bear upon the diagnosis before operation, and sufficient data have been accumulated to enable diagnosis to be made now with reasonable certainty. X-ray findings are adequately described by Waters and by Finney.

The report of King collected the cases of benign tumor up to 1917. The article of Golden included those up to 1928. Balfour and Henderson reported additional cases in 1929, Bookman in 1930, Scofield in 1930, and Finney in 1931 each reported cases.

The three cases of sarcoma (Mostowska, Soli and Von Solis) and the case herein reported, are the only ones of sarcoma in which we can find that

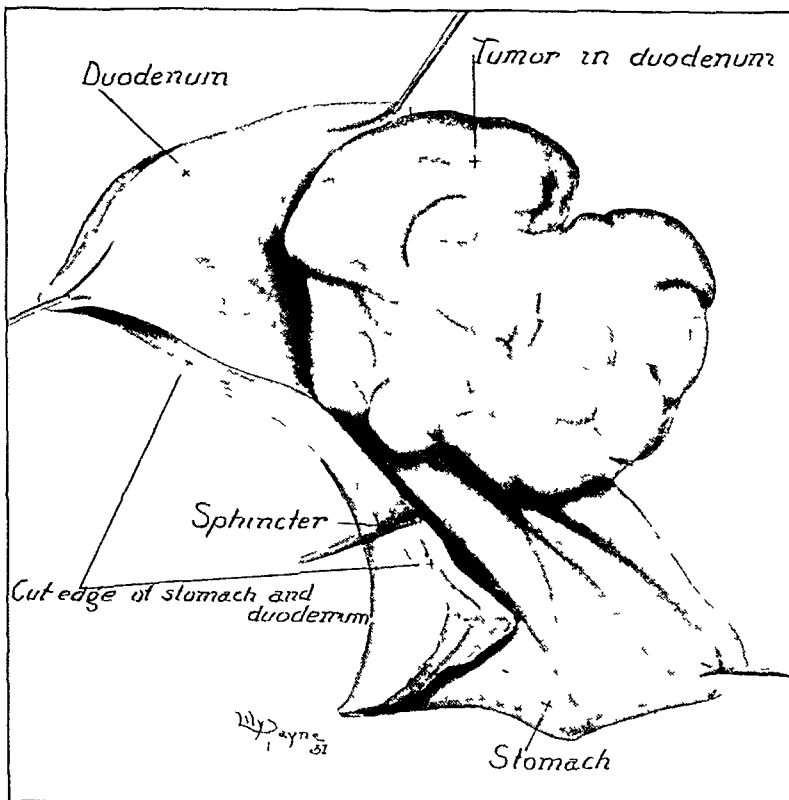


FIG 4—Artist's drawing of a side view of a sarcoma of the duodenum

diagnosis was verified. The two cases by the others above referred to were primary of the duodenum, and had metastasized to the liver, the mesentery and the peritoneum. The case in this article was metastatic from sarcoma of the thigh.

In twenty-four cases of benign tumor, the lesion in the duodenum was the only one found in the small bowel, in eight cases there were multiple tumors located in the duodenum, small bowel and large bowel, and in most of these there was multiple polyposis. Two of the cases were in infants, eleven and nineteen days old, respectively. There was one case of a man seventy-five years old. The other cases range in age from seventeen to sixty-eight, the majority being found between thirty and sixty.

## TUMORS OF THE DUODENUM

As to the nature of the benign tumors, twelve of the cases were adenoma, four were designated polyps, three myomas, one fibromyoma, one papilloma, one lipoma, one hæmangioma, one cyst, and several tumors of mixed type. Ulceration of the tumor or adjacent mucosa was present in one-fourth of the cases. The tumors varied in size from one to ten centimetres in diameter, and one of every four had pedicles. Questionable intussusception has been recorded only once.

*Symptoms and Clinical Course*—As would be expected, the chief symptoms were those referable to indigestion. Epigastric pain of a colicky charac-

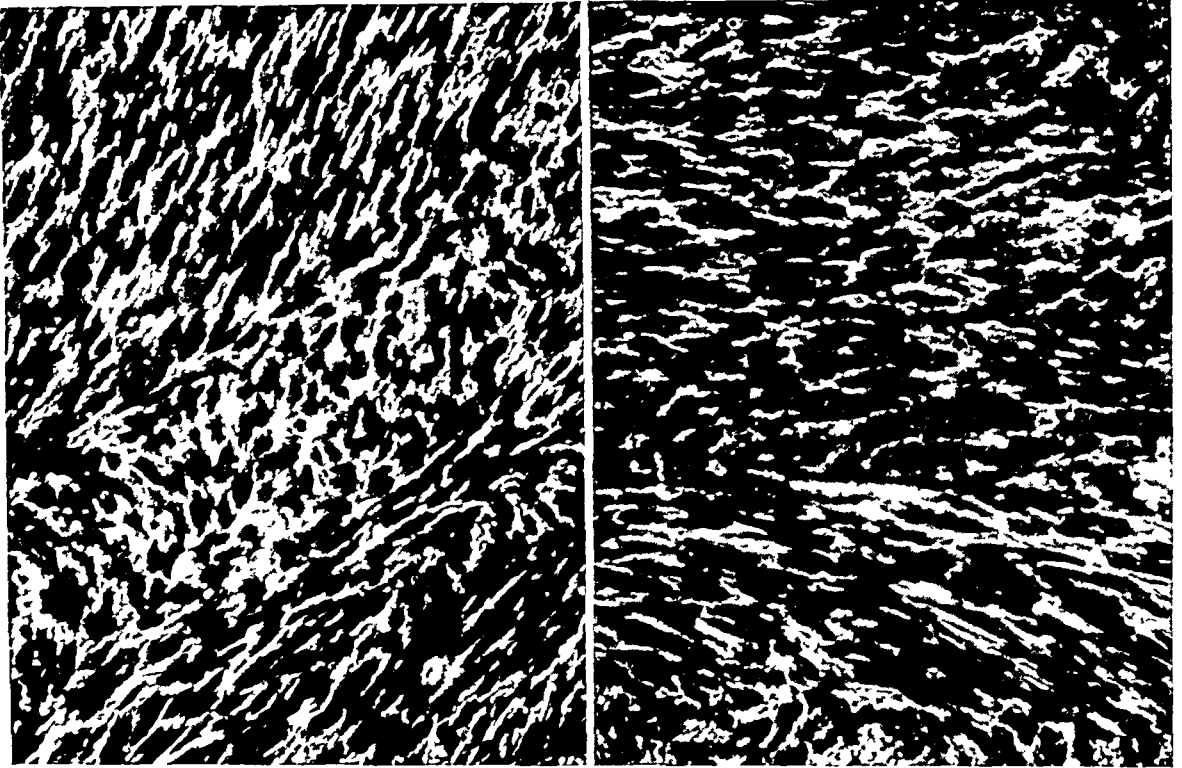


FIG 5A—Shows microscopical section of sarcoma of the thigh

FIG 5B—Shows microscopical section of sarcoma of the duodenum

ter was noted in all cases in which symptoms were recorded. The pain is recurrent, paroxysmal, variable in intensity, accompanied by tenderness, and attended or followed by vomiting. There is loss of appetite in all cases. Bowels are constipated or loose, and sometimes there is paroxysmal diarrhœa. Progressive weakness and loss of weight occur. Many cases have vomited and passed blood in the stools, in every case in which it is looked for, blood can be demonstrated by laboratory examination. Anæmia may or may not be present in benign tumors, but is marked and progressive in sarcoma. Emaciation occurs when vomiting is severe, and is serious in all cases of sarcoma.

Epigastric tenderness, sometimes visible and audible peristalsis will be noted, especially just before and during the paroxysmal pain. A palpable abdominal tumor has not often been found. In our case, it could be felt when the patient lay on her left side, but was not detected when she lay on her back.

Thus it is obvious that symptoms are those of disease in stomach or duodenum. Rontgen-ray examination is always called for, and by this means the diagnosis ought invariably to be made. Moreover, it is possible to make a differential diagnosis between tumor, ulcer, cancer and diverticulum of the stomach and duodenum.

Rontgen-ray characteristics are fairly definitely established. Usually the stomach examination is quite negative. As a rule, there is no six-hour residue, in the presence of marked atony of the stomach, and secondary anæmia, the stomach may be dilated, and often peristalsis is increased. There is regularly a filling defect in the duodenum. This defect may be circular, oval, vacuolar, or multilocular. It will show as a ring of barium around a translucent filling defect. The duodenal cap may or may not be dilated, and cannot be filled completely. A multilocular defect is suggestive of papilloma and a vacuolar defect is suggestive of adenoma or sarcoma. The defect is best shown with the patient in a right oblique position, though it is noted also in an upright and prone position, but frequently cannot be seen with the patient lying on the back. The deformity may easily escape observation upon fluoroscopical examination. Numerous films must be made in various positions to get the finest details of the appearance of the bulb.

The filling defect, especially when accompanied by dilatation of the duodenum, constitutes a reasonable basis for diagnosis of tumor, as distinguished from ulcer and diverticulum.

The differential diagnosis must be made from all diseases characterized by upper abdominal distress and indigestion, and must be borne in mind in considering the cause of any case of anæmia. Peptic ulcer, gall-bladder disease, carcinoma of the stomach, or pancreas, benign tumors on the stomach side of the pylorus, prolapsed into the duodenum, these lesions constitute the diseases from which differential diagnosis must be made. The problem of diagnosis is for the rontgenologist.

**SUMMARY AND CONCLUSIONS**—(1) Benign tumors and sarcomas of the duodenum are extremely rare. One case of metastatic sarcoma of the duodenum is reported, three cases of sarcoma and thirty-two cases of benign tumors of the duodenum have been collected.

(2) The disease has been found at various ages, from eleven days to seventy-five years of age.

(3) Tumors of the duodenum are associated with tumors in other parts of the intestines, in ten out of thirty-six cases recorded.

(4) The symptoms are those of "stomach trouble", recurrent epigastric pain, progressive loss of appetite, with nausea and usually vomiting, sometimes vomiting blood, often the passage of blood from the bowel, and progressive anæmia, weakness and emaciation, all more marked in malignant disease.

(5) Differential diagnosis is from pernicious anæmia, peptic ulcer, cancer, diverticulum, and from pedunculated tumors located in the stomach and prolapsed into the duodenum. This differential diagnosis can be made by properly conducted Rontgen-ray examination.

## TUMORS OF THE DUODENUM

(6) The treatment for tumors of the duodenum is excision of the duodenum, and anastomosis of the stomach to the duodenum by the Haberer or Finney method

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# DOUBLE PRIMARY MALIGNANT TUMORS OF THE COLON

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THE presence of more than one malignant tumor of an organ simultaneously, while uncommon, has a special pathological and surgical interest. Multiple malignant tumors of the skin are not considered unusual, and the polyposis of the rectum and sigmoid with several malignant areas are pointed out as examples of simultaneous primary malignant tumors. They are by all odds the outstanding example of the possibility of such a manifestation. Bergen and Rankin<sup>1</sup> have dealt with it fully when they say

Multiple primary malignant lesions in various tissues in one person, occurring at the same or widely separated periods of time, have been frequently recorded. Similar malignant tumors occurring in the same organ at the same or different times, have rarely been described. Carcinomata of a hollow viscus that are essentially alike or closely related and that are distinctly separate primary malignant lesions are rare but probably they are not as infrequent as formerly has been supposed. That this fact has a bearing on treatment and prognosis needs no further comment.

Taking up individual organs or even systems, the number of cases of proved multiple primary foci is a small one, but doubtless many cases have been observed but not reported.

Major<sup>2</sup> has made an exhaustive study and classification of multiple primary malignant tumors. In nine cases he found they were in the organs belonging to the same system.

Norbury<sup>3</sup> believes there is more close relation between multiple adenomata and cancer of the rectum and colon. He says "At any period in the development of an adenoma the epithelium may assume invasive properties, and the tumor becomes a carcinoma. Such a carcinoma may therefore be regarded in the light of an accidental happening in a previously existing adenoma."

In order to establish the individuality of the growths present, certain requirements have been suggested, the fulfillment of which is necessary to eliminate the possibility of metastasis. This is not always possible, although clinically there may not exist the least doubt about the tumors being unrelated.

Miller<sup>4</sup> discusses this phase of the clinico-pathological side of the question. He reports five cases. In three, carcinomata was present in the colon simultaneously and in the remaining two cases an interval of considerable time elapsed between the development of the tumors in the bowel. He notes the difficulty in establishing the individuality of simultaneous growths and questions the practical application of Billroth's formula as a criterion of the proof of the independence of each growth.

Billroth is credited with having laid down these requirements:

(1) The two growths must show distinct histological differences and must be so pronounced as to exclude their interpretation as merely different stages of development.

(2) Each growth must have its own group metastasis.

(3) Each growth must originate from its own epithelium.

Mercanton adds a fourth requirement:

If both growths are removed at operation and recurrence does not follow, it carries the conviction that each growth was primary

This is a requirement that is difficult to fulfill, inasmuch as it necessitates the cure of the patient with two malignant growths in the same organ

The question of metastasis is the one which projects itself into the discussion, because we cannot formulate a test by which a metastatic growth is positively identified. We have accepted opinions concerning the channels by which a new field may be invaded, but we do not know if there are not some exceptions. There are very strong reasons for believing that obstruction of a lymphatic duct may be the cause of a metastatic growth in a wholly unexpected organ or tissue, and dissemination by the blood-stream seems to be the only logical explanation of some carcinomatous deposits

While the discussion of primary and secondary carcinomata in the same organ or system is a fertile field for speculation and research, the clinical side must always appeal to the surgeon as the more interesting and important, as the immediate recovery and permanent cure depend on the operative judgment and mechanical ability

The infrequency of two simultaneous malignant lesions in an organ has naturally made the search for such a condition, both before and during operation, not a matter of routine, and such cases are found by accident rather than by diligent effort. Fenger<sup>5</sup> had such an experience, probably the first double carcinoma of colon reported in this country (1888)

A surgeon can never be so mentally versatile that he will be familiar with all the possibilities which may be unfolded by the open abdomen. This applies equally as well to the roentgenologist and internist. There is little wonder, then, that in the literature concerning multiple malignant tumors of the colon, we find the failure of a colostomy to relieve an obstruction the first inkling of the presence of a second obstructing growth. Cabot<sup>6</sup> made the diagnosis of double carcinoma in a case and prepared to do two resections, separated by a reasonable period of time. The patient succumbed a few days after the first stage operation. The patient was a bad risk, having anæmia, syphilis, enlarged liver and enlarged spleen

How this oversight may be prevented may appear simple, namely, institute a routine examination of the colon in all cases, even when a single malignant tumor is definitely located prior and during the operation. But with the accuracy of the X-ray, the insignificant number of multiple growths, and some mechanical difficulties that present themselves in exploration, it would seem that such a critical examination of the colon would seem unnecessary or impossible in every case. It does not seem practical to formulate a procedure that would pick up the rare case without enforcing a hardship, economic or otherwise, on the immense majority of patients having but a single tumor. We can only suggest, from a most limited experience, that those cases from a roentgenological standpoint, that present any variation from the typical malignant obstruction should be carefully re-studied, and at operation the examination of the entire colon should be undertaken if possible





FIG 1

FIG 1—A barium enema showed a very definite obstruction at the hepatic flexure. This obstruction was almost complete, with slight canalization and irregular filling defects very typical of an ulcerating malignancy. A few days later when another diagnostic barium enema was given and the patient was examined under the fluoroscope, considerable difficulty was noted in the enema passing the sigmoid area. Because of the long redundant sigmoid no direct view could be secured of the obstructed area. The malignant obstruction at the hepatic flexure was still quite evident. These conditions were reported to the surgeon at the operating table before incision.

FIG 2

FIG 2—About two weeks later after colectomy had been done the entire specimen removed was filled with barium. At this time the obstruction in the sigmoid was complete and that at the hepatic flexure almost entirely so.

## DOUBLE COLON CANCER

This is just another way of stating that we *hope* to recognize the next case of this type that may come under our care

The following case appears to us to be undoubtedly one of double primary adenocarcinoma of the colon

CASE—C S, male, thirty-seven years of age, was referred by Dr W J Mallory, who furnished the following history

First seen February 12, 1930 Thirty-five years of age Height 5 feet seven inches, weight 130 (should be 150) Temperature 98.4°, pulse 88, blood-pressure 120/75 Pain in the lower abdomen intermittent recurring about every three minutes, not affected by food Constipation and loss of weight This pain began about six weeks previously The pain is not relieved by food, laxatives, belching of gas, soda, or rest It occurs both night and day Appetite is good Sleep is interrupted by pain Bowels constipated moderately, but relieved by mineral oil He has lost five pounds in six weeks The family history presents no information relative to his present illness

*Physical examination*—Nervous system negative Gums apparently healthy Tonsils have been removed, there are no tags remaining The epitrochlear glands are palpable Heart and lungs clear The abdominal organs are not palpable No localized tenderness, tumors, or muscle spasm

*Laboratory examinations*—Test breakfast—30 cubic centimetres Free hydrochloric acid 24, total acidity 32 Benzidine negative Microscopically negative

Urine, February 14, 1930, straw, clear, acid, 1018 Sugar negative, diacetic plus Microscopically, occasional oxalate, no pus, no casts Fæces, February 14, 1930, soft, unformed, well digested, slight fermentation, streaks of bright red blood Benzidine inky, guaiac 3 plus, microscopically negative

Fluoroscopy, lungs appear normal, other than moderate fibrosis about the hila Heart for type of individual seems broad Stomach slightly low but normal in every other respect Duodenal cap well visualized and appears normal No six-hour residue, a peristaltic rush across transverse colon At twenty-four hours the entire colon visualized Cæcum freely movable, transverse colon slightly spastic, sigmoid appears normal The rectal pouch is drawn

When seen March 9, 1932, the patient presented the usual signs of an incomplete intestinal obstruction, involving the large bowel Moderate distention was present but no mass could be palpated

An X-ray examination (Fig 1) made March 2, 1932, was reported *Diagnosis*—Indeterminate Obstruction at hepatic flexure (Fig 2) Cause (?)

X-ray examination March 5 determined a diagnosis of annular carcinoma of the colon at the hepatic flexure

Operation March 9, 1932, a long right rectus incision disclosed a large nodular mass in the hepatic flexure of the colon Further exploration of the abdomen revealed an equally large mass in the sigmoid of the same nature as the one in the hepatic flexure An ileocolostomy was done, with a loop of the ileum about twelve inches from the cæcum at the rectosigmoid junction The post-operative convalescence was without note except slight superficial infection in the wound

Two weeks later a second operation was undertaken, the patient was transfused at the same time, owing to the infection in the primary wound, the incision was made in the left rectus, and it proved to be disadvantageous, owing to the inaccessibility of the growth in the hepatic flexure The immobility of the colon at this point made its removal somewhat difficult The entire colon with about six inches of the ileum was removed The patient had moderate but not alarming shock and progressed well until the fourth day, running a rather rapid pulse, moderate elevation of temperature, but vomiting was never present On the evening of the fourth day, he became restless, pulse further accelerated and further elevation of temperature He died the following day X-ray examination of

the chest on third day after second operation showed some pulmonary congestion and œdema, but hardly sufficient pathology to explain the high temperature and rapid pulse of the patient. Permission for autopsy was refused, but death was probably due to



FIG 3—Shows malignant growths at hepatic flexure and in sigmoid

peritonitis. Laboratory reports—March 5, red blood-cells, 4,060,000, white blood-cells, 11,790, hæmoglobin, 72 per cent. Urine showed a faint trace of albumen and a few hyaline casts. The Wassermann was negative. On March 22, the day prior to the

## DOUBLE COLON CANCER

second operation, the blood was reported as follows red blood-cells, 3,600,000, white blood-cells, 11,800, hæmoglobin, 45 per cent The urine on the same day showed a few hyaline and few granular casts

*Comment*—Multiple malignant growths of the colon are unusual, but probably not as infrequent as statistics would indicate An X-ray pre-operative diagnosis is possible, but it would not be made in the routine examination of the colon unless the roentgenologist possessed some uncanny diagnostic ability It is possible that further X-ray study of the atypical obstruction may lead to the recognition of multiple malignant lesions In view of the fatality in our only case, it may be proper to consider a double resection or even operation in three stages better surgical judgment

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# ACUTE OBSTRUCTION OF THE DUODENUM DUE TO SUBMUCOUS HÆMATOMA

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THE retroperitoneal fixed position of the duodenum gives it an immunity to acute obstructions caused by twists, bands, or invaginations, except at its junction with the pylorus or with the jejunum. The following case is deemed worthy of being reported because of the rarity of acute duodenal obstruction and the very unusual etiology found. Duodenal stenoses caused by congenital membranes or septa, scarring from ulcers, benign and malignant tumors either intrinsic or extrinsic, external bands, pressure of the mesentery containing the superior mesenteric vessels, or impaction of foreign bodies, though rare, are well-recognized entities. Infrequent cases of acute obstruction have followed gastroenterostomy, acute impaction of gall-stones or other foreign bodies, and retroperitoneal hæmorrhage. In 17,652 autopsies at the Guy's Hospital, there were only seventeen cases of chronic and acute obstruction of the duodenum.<sup>1</sup>

The relation of acute dilatation of the stomach to duodenal obstruction is not clear. Corroborating the findings of Novak,<sup>2</sup> Dragstedt, Montgomery, Ellis, and Matthews<sup>3</sup> comment on the absence of dilatation of the stomach in those cases of very high intestinal obstruction that have been reported as a result of various causes. In the case here reported, extreme gastric dilatation could be attributed to either of two causes, duodenal obstruction or acute pancreatitis, or possibly their combination.

L K, No 303587, a married woman of forty-two years, born in the United States, a laundress by trade, was admitted June 14, 1929. Her past history was negative except for a mastoidectomy five years previously and an abscess of the right side of her face fifteen years previously. She was well until three weeks before admission when she had an attack of colicky pain, peri-umbilical in location, associated with vomiting but with no constipation. These symptoms disappeared completely after about four days. Four days before admission she was suddenly seized again with colicky pains in the epigastrium and peri-umbilical region which persisted and were very severe. Continuous vomiting had been present until five hours before admission. She had no bowel movements but had passed flatus. Gaseous eructations were present. The abdomen had become markedly distended, there were no urinary symptoms. She was an extremely obese woman. She lay in a state of marked shock with cold clammy skin, her temperature was 100.4°, pulse, 120. The abdomen was markedly distended, perhaps more in the left upper quadrant than elsewhere, shifting dullness was noted. Tenderness was present all over the abdomen and most marked in the upper quadrants, especially in the epigastrium, there was also moderate rigidity in the upper quadrants. An indefinite mass seemed to occupy the left upper quadrant but no other details could be made out. Vaginal examination was negative. Rectal examination was negative, the presence of faeces was noted. The rest of the physical examination was negative.

## OBSTRUCTION OF DUODENUM

The blood count showed white blood-cells, 31,000, polymorphonuclear leucocytes, 88 per cent, lymphocytes, 8 per cent, mononuclears, 4 per cent. The urine was negative. The blood-pressure was 110/90.

Abdominal X-ray examination showed no unusual dilatation of the gut by gas. The entire abdomen was obscured by a homogeneous shadow of moderate density which suggested the presence of fluid. Stimulating measures including intravenous infusion were employed to bring the patient out of shock before operation. The patient was subjected to operation several hours after admission.

A three-inch right para-umbilical incision was made, on opening the peritoneum a tense, enormously distended purplish viscus was encountered. At first this was thought to be a large ovarian or renal cyst. On tracing it farther, however, the operator found this huge cyst-like mass to extend upward beneath the liver and thence under the left diaphragm. After removal of the examining hand from under the left diaphragm, a moderate amount of bloody, somewhat turbid fluid escaped. It was then recognized that this mass was the extremely dilated stomach. A stomach tube was passed into it from the mouth and a large amount (3,500 cubic-centimeters) of grayish-green, thin fluid resembling pea soup was expressed until the stomach was empty. Upon further exploration, the pyloric ring was felt to be somewhat thicker than normal but admitted a finger. There was some fibrinous exudate on the under surface of the liver surrounding the gall-bladder. The latter, however, was normal except for two small stones. It emptied with ease. The head of the pancreas felt much larger, wider, and firmer than normal. The under surface of the transverse mesocolon showed several irregular hæmorrhagic areas measuring three by two centimeters, in the centre of which were several flat grayish-white lesions which had the appearance of fat necrosis. There was a similar hæmorrhagic area seen on the superior leaf of the mesentery. The uterus contained a few small fibroids and the adnexa were normal. The first and second parts of the duodenum were palpated but no obstructive lesion was detected. The impression was that we were dealing with an acute pancreatitis with fat necrosis with reflex acute gastric dilatation as no obstructive lesion was found. A rubber dam drain was placed in the foramen of Winslow.

*Post-operative Notes*—At the termination of the operation the patient was in extremely poor condition. Stimulating measures were administered but she failed to rally and died thirty minutes after the close of the operation.

*Necropsy* June 14, 1929. Thorax, negative.

*Abdomen*—About 1,000 cubic-centimeters of thin yellow-brown fluid are found in the left upper quadrant beneath the diaphragm. The stomach is remarkably dilated and its serosal surface is red and dull. At the root of the mesentery both in the region of the caput coli and the right kidney there are red areas of retroperitoneal hæmorrhage.

*Liver*—Normal. The gall-bladder contains fifty cubic-centimeters of green bile and two small calculi, one centimeter in diameter. The common bile-duct is patent and shows slight dilatation which extends into the intrahepatic bile-ducts. The portal vessels are negative.

*Pancreas*—Large, measuring 15 by  $3\frac{1}{2}$  by  $2\frac{1}{2}$  centimetres. It appears swollen. The surface shows numerous spots of fat necrosis and is slightly injected throughout. There is a small hæmorrhagic area in the head of the pancreas. Cut sections present numerous areas of fat necrosis throughout the organ. The pancreatic lobular structure is well-preserved and brown in color. There is a rather sharply circumscribed tumor the size of a hazel-nut at the head of the pancreas. It is firm, grayish-white and fibrous in appearance. In its centre there are several lumina, apparently dilated ducts, varying in size, which are filled with grayish thick mucus. The duct of Wirsung opens into the ampulla of Vater. It is slightly narrowed at its opening into the duodenum.

*Duodenum*—The second portion appears hæmorrhagic. On opening the duodenum anteriorly, one sees a tremendous submucosal hæmorrhagic infiltration involving its entire circumference, beginning about six centimetres from the pylorus and extending to about

the junction of the second and third portions of the duodenum. At the region of the head of the pancreas this infiltration forms a large hæmatoma about the size of a tangerine orange which fills the duodenal lumen and completely obstructs it. Above the hæmatoma the duodenum and stomach are found to contain a large amount of greenish bloody fluid.

*Stomach*—The stomach is greatly dilated and filled with greenish bloody fluid. The mucosa is hæmorrhagic, especially that of the greater curvature. At the lesser curvature, near the cardia, there is a large ulcer measuring  $4\frac{1}{2}$  by 10 centimetres. The base of the ulcer is paper thin and apparently composed only of serosa. Its borders show no reaction. The lesser curvature externally over this ulcer is covered with fibrinous material.

*Æsophagus, small intestine, and large intestine* are essentially negative except that the contents below the duodenum are seen to be composed of thin, watery, clay-colored stools with a peculiar silver-grayish sheen to them.

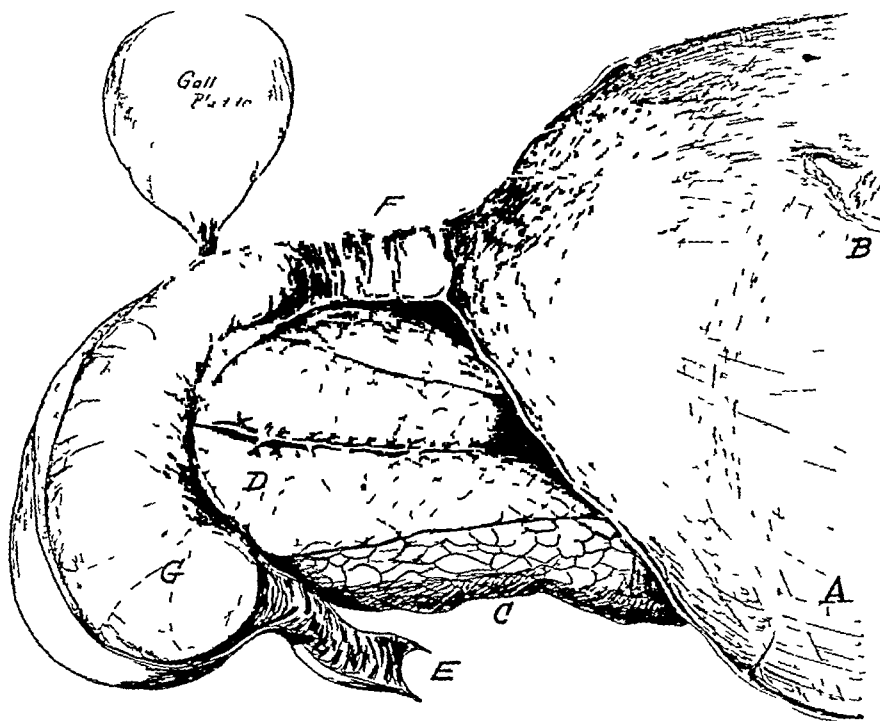


FIG 1—Semi-diagrammatic sketch of post mortem specimen. A—Stomach, B—Tension ulcer, C—Pancreas, D—Location small adeno carcinoma head of pancreas, E—Third portion duodenum, F—First portion duodenum, G—Submucous hæmatoma of duodenum.

*Microscopical Examination—Pancreas*—There are many small bluish areas in which the acinal cells show necrosis and necrobiosis. The interlobular septa show an infiltration with polymorphonuclear leucocytes. Within the head of the pancreas are islands of cylindrical and irregularly shaped cells which frequently form pseudo-glands. They have the typical appearance of an adeno-carcinoma.

*Duodenum at the level of the pancreas* shows a large submucous hæmatoma. There are islands of infiltrating adeno-carcinoma in the duodenal wall.

One of the paratracheal lymph-nodes shows carcinomatous metastases.

*Final Diagnosis*—Adeno-carcinoma of the head of the pancreas infiltrating the duodenal wall with dilatation of the pancreatic ducts and metastasis to a paratracheal lymph-node. Acute pancreatitis. Submucosal hæmatoma of the duodenum with complete obstruction.

Fat necrosis of the pancreas, omentum, and mesocolon.

Acute dilatation of the stomach with tension ulcer and hæmorrhages. Localized acute fibrinous peritonitis. Cholelithiasis.

## OBSTRUCTION OF DUODENUM

The diagram (Fig 1) illustrates the large submucous hæmatoma obstructing the second portion of the duodenum with a huge gastric dilatation. The stomach shows the type of tension ulcer along the lesser curvature which occurs with severe dilatation. Through the serosa overlying it seepage took place causing the peritonitis. The site of the very small carcinoma of the head of the pancreas and the moderate dilatation of the pancreatic ducts behind it is indicated.

No large bleeding vessel could be found as the cause of the obstructing duodenal hæmatoma. The bleeding may have resulted from the erosion of a small blood-vessel incident to the acute pancreatitis. The latter condition was possibly initiated by rupture of dilated ducts behind the carcinoma which

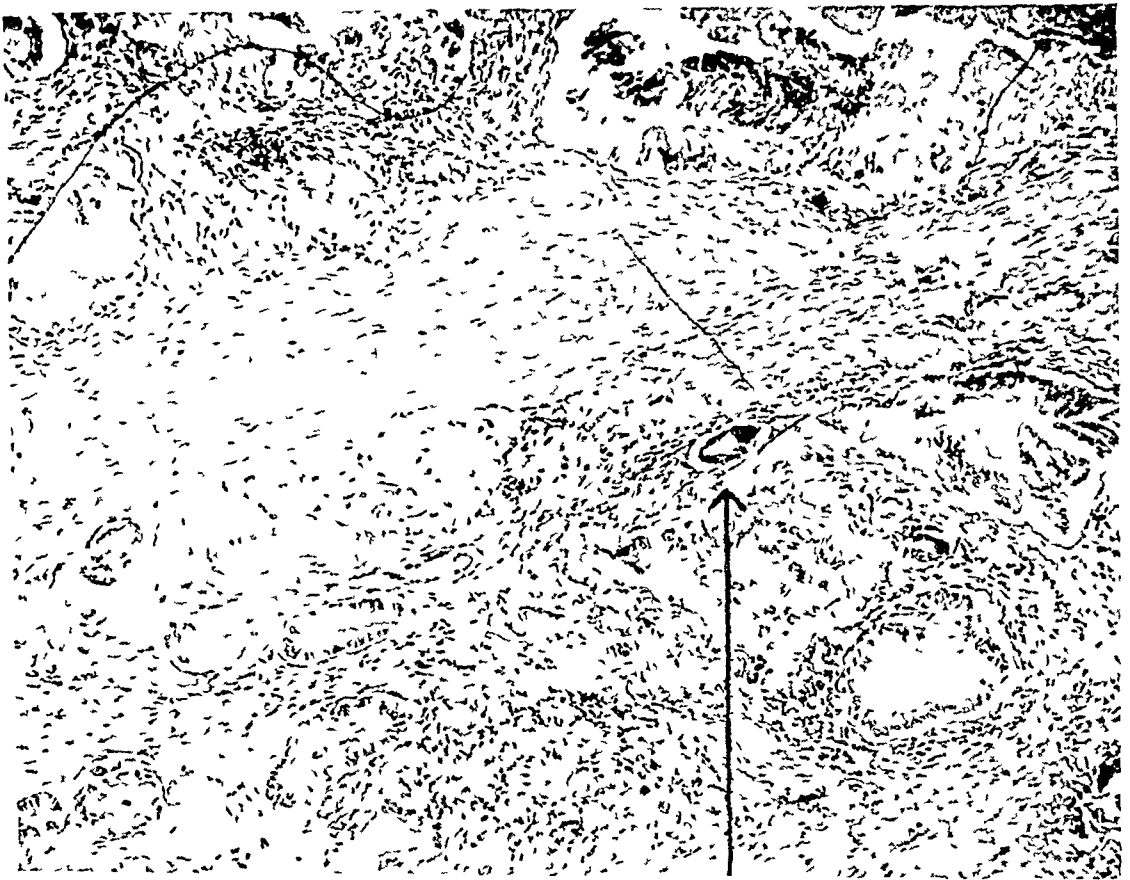


FIG 2—Carcinoma cells in duodenal wall

obstructed them. More likely, however, the bleeding may have come from a vessel in the duodenal wall which was eroded by the infiltrating carcinoma (Fig 2). At any rate, coincidental with the small carcinoma of the head of the pancreas and acute pancreatitis there developed acute obstruction of the duodenum by a submucous hæmatoma. As a sequel to the obstruction and to the acute pancreatitis the stomach became extremely dilated.

The extent of this dilatation was comparable with that attained in cadavers by Revilliod and Key Abeig,<sup>4</sup> in some experiments reaching 4,000 cubic centimetres. The rupture of the mucous membrane along the lesser curvature at the cardia which occurred in their experiments coincides with the finding in this case. Cases have been reported of rupture of the stomach due to



chronic and subacute duodenal stenosis<sup>5</sup> Rupture of the apparently normal stomach from overdistension has occurred, the place of rupture has always been along the lesser curvature near the cardia<sup>5</sup>

The etiology of the acute pancreatitis in this case was apparently the rupture of a dilated duct within the pancreas behind an obstruction caused by the carcinoma in its head

Interesting from another standpoint was the finding of metastatic adenocarcinoma in a paratracheal lymph-node This had already become established despite the fact that the primary focus in the pancreas was still very small and had produced no symptoms until the onset of the acute illness

Only two other cases of duodenal obstruction due to hæmatoma have been found in the literature The first case<sup>1</sup> was that of a man of twenty-three years admitted to the hospital for an abdominal aneurism attributed to an injury Death resulted suddenly from its rupture Besides the large quantity of blood found in the peritoneal cavity, there was much recently coagulated blood anterior to the pancreas and adjacent to the third portion of the duodenum Here the bowel was so compressed that it would barely admit a finger The stomach and duodenum were filled with fluid while the jejunum was collapsed The second case<sup>2</sup> was that of a driver whose abdomen was compressed between two cars Two hours later he was observed in the hospital where his pulse was found to be 76, there was no vomiting He had some pain but his general condition was good On the next day his condition was still good On the third day he vomited continuously, his stomach seemed to be dilated and his general condition seemed bad An X-ray examination showed an obstruction between the second and third portions of the duodenum On the fourth day a laparotomy was performed, the duodenum was found to be pushed forward and to the left by a large retroperitoneal hæmatoma the size of a hen's egg This was evacuated and the patient made an uneventful recovery

It is thus seen that the fixed position of the duodenum makes this portion of the gut more susceptible to obstruction from retroperitoneal hæmorrhage than any other portion of the gut Cases of gall-stone obstruction have been reported Borchgrevink,<sup>7</sup> Thompson<sup>8</sup> and many others have reported such lesions Other foreign bodies rarely cause obstruction, they are usually followed by perforation and peritonitis

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# PERFORATED PEPTIC ULCER IN GERMAN CLINICS

AN ANALYSIS OF 4,402 CASES

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THE common presence of multiple peptic ulcers in German or Central European patients with perforated peptic ulcer has encouraged the German and Austrian trained surgeons to resect the stomach primarily. Reports in the German literature demonstrate that such radical surgery not only cures most patients of all peptic ulcers present, but is also attended by a surprisingly low mortality rate.

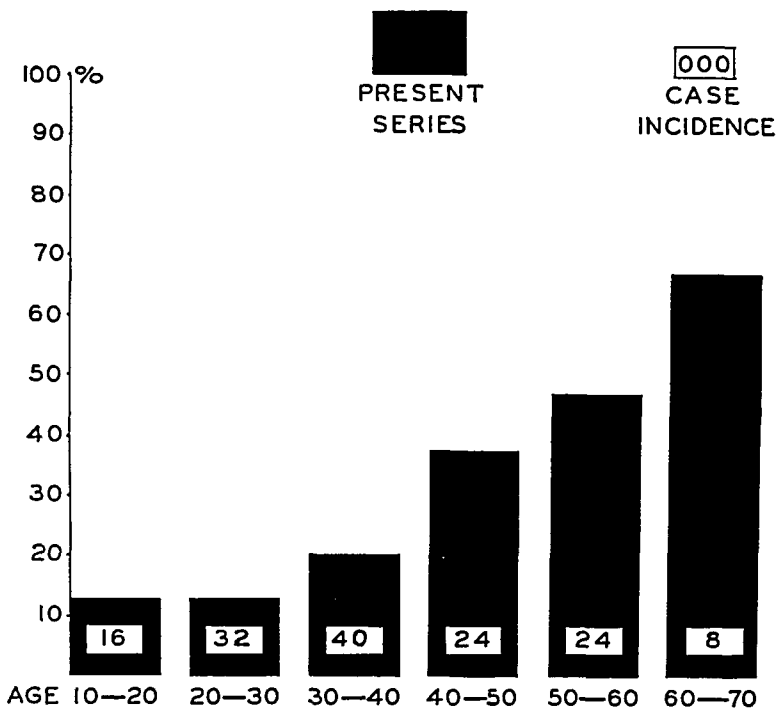
The following study of perforated peptic ulcer and its treatment in Germany and Central Europe is presented believing that it is of interest and not with the intention of encouraging the institution of surgical measures which seem too radical for the successful handling of the usual type of perforated peptic ulcer encountered in North America. It is based on 144 cases personally collected in the University Clinic of Professor Victor Schmieden at Frankfurt am Main. In addition are considered 4,258 cases reported from other clinics of the German or Austrian schools of surgery, making a total of 4,402 cases.

Bauer, Aschner, Brutt, Zukschwerdt and Eck and others believe that there is a hereditary predisposition to peptic ulcer and thus to perforation. That some individuals repeatedly develop perforating peptic ulcers is well known. The perforated peptic ulcer patient in Germany differs from the one often pictured by American authors. He is usually a strong and well-nourished individual who eats excessive amounts of coarse foods, drinks a considerable volume of fluids, and works hard. Various authors estimate that over 60 per cent of perforations occur in laborers. That 55 to 95 per cent of these patients give a history of having had ulcer symptoms for days or even years preceding perforation is indicated in reports of Speck, Brutt, Wagner, Kuntz and others. In the present series one-third of the cases had been or were being treated for peptic ulcer, and the records show that 90 per cent had had symptoms previous to those of actual perforation. Speck, in reviewing the world literature on perforated peptic ulcer, says that 10 per cent of all peptic ulcers perforate. Hart believes that perforation occurs in 10 per cent of all patients with duodenal ulcers, and Cukor states that it occurs in 65 per cent of all patients with gastric ulcers and in 25 per cent of those with duodenal ulcers. Although these percentages are merely estimations, they are probably not far from correct.

Formerly, the majority of peptic-ulcer perforations occurred in women. Brunner, in 1903, and Shoemaker, in 1914, reported incidences of 80 per

cent and 52 per cent, respectively, in women, but later studies give lower percentages and most of the recent ones contain few or no cases in women E Schwarz reports 30 per cent, Prader, 12 per cent, Kott, 12 per cent, Zukschwerdt and Eck, 6 per cent, F Schwarz, 8 per cent, Cukor, 3 per cent, Schulein, no occurrences in women, and in the present series there were only three cases in women up to 1926 and none since then This markedly decreasing incidence in women has not been satisfactorily explained

Perforation of peptic ulcer occurs most frequently in the third and fourth decades of life and the prognosis is more favorable in those under



### INCIDENCE AND MORTALITY RATE PERCENTAGES BY DECADES OF LIFE

GRAPH I—Illustrates the incidence of perforated peptic ulcer and the mortality rate percentages by decades of life in the present series

forty years of age (Graph I) Its occurrence in adolescence is not uncommon, and it has been reported in the aged Speck observed one perforated ulcer in a patient seventy-seven years old, Schulein one in a patient of seventy-five years, and Kuntz one in a seventy-four-year-old individual

The time elapsed between ingestion of food and perforation of peptic ulcer is variously given by different authors Bager found that two-thirds of the perforations occur in the daytime, mostly between four and six P M, which is three to five hours after eating the main meal, but Brunner observed that 50 per cent perforate within two and a half hours after eating That they may occur more frequently in the fall is shown by Brunner, Bager, Zukschwerdt and Eck, but all authors do not concur in this finding

## PERFORATED PEPTIC ULCER IN GERMANY

Eck and Zukschwerdt had one case and quote another, and Eichelter observed two cases in which perforation occurred during iontgenographical examination Panek, Bundschuh, Steiger, Mandl, Albrecht and others have warned about this danger In the Schmieden Clinic, one fatal perforation occurred while a patient was undergoing a gastric analysis

That frequently there is a multiplicity of peptic ulcers in German patients with perforated peptic ulcer is a proven fact Not uncommonly one or more of the additional non-perforated ulcers are chronic penetrating ones (Fig 1) Ulcers are multiple, according to Brunner, in 32 per cent, Speck, 50 per cent, Schulein, 20 per cent, Prader, 25 + per cent, Brutt, 43 per cent, Hart, 38 per cent, Gruber, 48 per cent, E Schwarz, 26 per cent, Eichelter, 30 per cent, Enderlen and Redwitz, 20 per cent, Petren, 27 per cent, Neumann, 40 per cent, and Zukschwerdt and Eck,



FIG 1

FIG 1—Perforated ulcer of lesser curvature of stomach, multiple small gastric ulcers and old ulcer scars in pyloric area



FIG 2

FIG 2—Large calloused ulcer of lesser curvature

29 per cent Although the older records of the Schmieden Clinic do not show a high incidence of multiplicity of peptic ulcer, it would seem from later records and from personal observations that 30 per cent is not too high a general incidence of multiplicity The ulcers that perforate are usually the large, calloused ones (Fig 2) occurring in a stomach that shows atrophic (Fig 3) or hyperplastic (Fig 4) changes of a long-existing gastritis Perforations are occasionally as large as three centimetres in diameter and not infrequently they are one centimetre in diameter Simultaneous perforation of two peptic ulcers is not unknown Brunner found eight instances, Zukschwerdt and Eck report one case, and from the Schmieden Clinic the author adds two more Shoemaker's estimate that there are double perforations in 3 per cent of cases is probably too high

Statistics collected from the literature indicate that perforated ulcers are as common in the stomach as in the duodenum and that mortality rate for both is approximately the same However, the author agrees with Eichelter, who believes that these studies are subject to error and states that

70 per cent occur in the duodenum or pyloric area. Exact localization of the perforation at the time of operation is often difficult. Findings are not infrequently incorrectly recorded and some authors consider the pyloric area as stomach while others class it as duodenum. In the present series, there were recorded four perforations in the cardia, thirty-four in the stomach, forty-one in the pyloric area, and sixty-five in the duodenum. The mortality rate was 26 per cent for those occurring in the duodenum and the pyloric area, 38 per cent for those in the stomach, and 50 per cent for those in the cardia. It is regrettable that there are no large series which are of real value in determining the mortality rates for different sites of perforation.

The justification for surgery in cases of perforated peptic ulcer was



FIG 3



FIG 4

FIG 3 —Perforated ulcer in the duodenum and atrophic gastritis

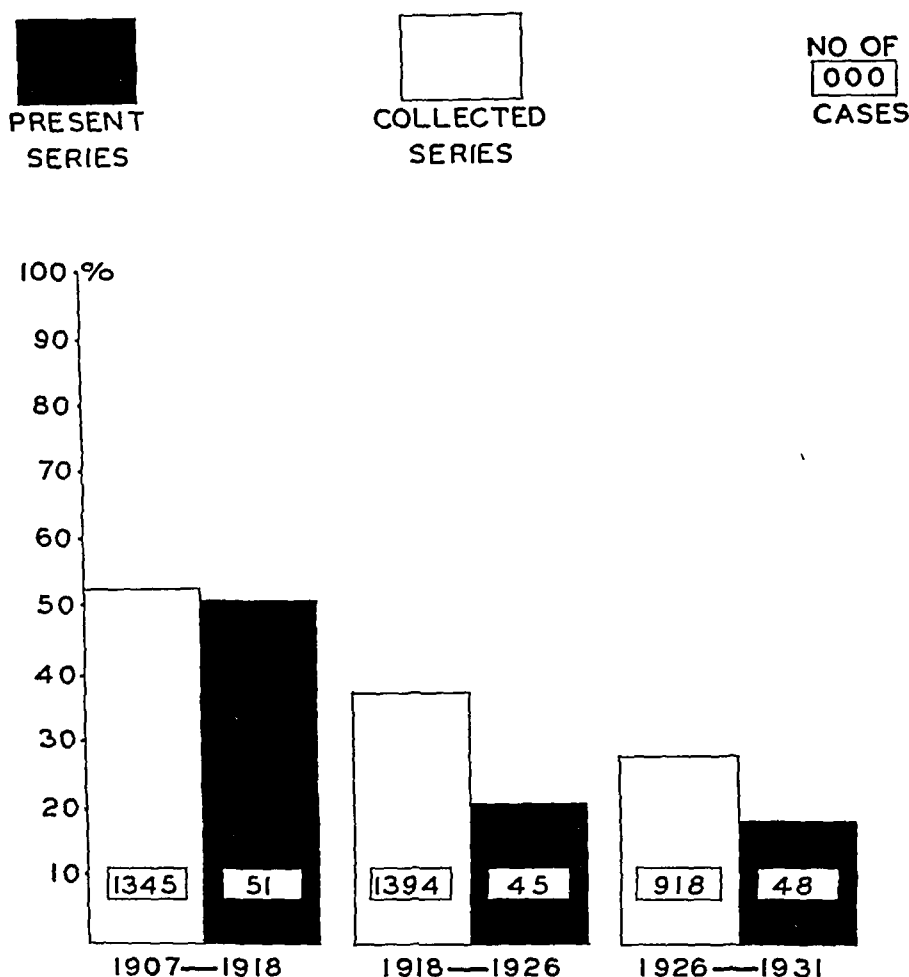
FIG 4 —Perforated ulcer and old ulcer scars in the pyloric area. Stomach mucosa is hyperplastic

demonstrated by the successful operations of Heussner and Roux in 1892, twelve years after Mikulicz had failed in the first case ever operated upon. In 1897, Mikulicz collected 103 surgically treated cases in which there was a mortality rate of 68 per cent. Brunner, in 1903, collected the first large series, one of 387 cases, with a mortality rate of only 48 per cent, but he called attention to the probability that only the better results were being reported and expressed the belief that the true mortality rate was about 68 per cent.

That immediate surgery is the method of choice in the treatment of perforated peptic ulcer is demonstrated in Graph II, which shows for the present series a mortality rate that decreased for successive intervals of time from 50.9 per cent (1907 to 1918) to 20 per cent (1918 to 1926),

## PERFORATED PEPTIC ULCER IN GERMANY

and finally to only 16.6 per cent (1926 to 1931). It will be noted that in the collected series, there is a corresponding decrease (Graph II) when these are grouped into the same periods of years, but it is not so evident when individual series (Table I) are studied. The discrepancy is due to series that begin many years prior to reporting. This decrease can be attributed in part to improvement in technic and more correct diagnoses, but mainly to the system of the practice of medicine on the continent. More than the majority of Germans are compelled by law to carry sickness insur-



### MORTALITY RATE PERCENTAGES FOR ALL OPERATIONS BY YEARS

GRAPH II—Shows the number of patients operated upon and the decreasing mortality rate percentages in the present and collected series by periods of years

ance in the indirectly governmental controlled Krankenkassen, which have become very powerful. The requirement for economies from such organizations has resulted in fewer hospitals, but these are large, well equipped, well staffed, and are either under the direction of university medical schools or men who have been trained for fifteen to twenty years in university clinics. A patient with symptoms of any severity immediately calls a physician whose fee is paid by the Krankenkasse, and thus an early diagnosis becomes the rule rather than the administration of home remedies.

# AMOS M GRAVES

## TABLE I

*Table Illustrating the Decrease in Mortality Rate Percentage by Years for the Collected Series  
The Number of Each Operation Used and the Mortality Rate Percentage for Each Are Indicated*

Author	Year Reported	No of Cases	Mortality Rate Percentage	Operation Used and Mortality Rate Percentage
Mikulicz	1897	103	48	
Brunner	1903	387	48-68	
Neumann	1913	31	55	15 sutured, 60%, 3 closure and G-E, 66 6%, 13 by own catheter method, 48%
Wagner	1913	15	40	12 sutured, 33 3%, 3 closure and G-E, 66 6%
Seidel	1913	25	28	all sutured
Shoemaker	1914	784	48	suture, closure and G-E
Schulein	1921	21	47 6	suture, closure and G-E
Noetzel	1921	26	40	suture, closure and G-E
Brütt	1921	140	40	suture, closure and G-E, 12 resections, 33%
Cukor	1921	34	29 5	all sutured
Schmidt	1921	19	16	11 sutured, 8 closure and G-E
Wagner	1922	46	44	suture, closure and G-E
Zoepfel	1922	37	40	suture, closure and G-E, 20 resections, 25%
Roepke	1922	19	16	closure and G-E in all
Steichele	1923	53	59	closure and G-E in all
Speck	1923	105	42	33 sutured, 54 5%, 62 closure and G-E, 32 2%
Blumenthal	1923	557	40	suture, closure and G-E
Novak	1923	20	30	17 sutured, 3 closure and G-E
Mulleder	1923	18	28	1 sutured, 17 resections, 29%
Brütt	1923	25	12	suture, closure and G-E, 10 resections, 30%
Engelsing	1924	38	26 3	suture, closure and G-E
Eichelster	1925	27	63	suture, closure and G-E
E Schwarz	1925	57	54 3	32 sutured, 70%, 20 closure and G-E, 40%, 5 resected, 20%
Amberger	1925	57	37	suture, closure and G-E
Abrahamsen	1925	85	20	all methods
Naumann	1926	126	62	suture, closure and G-E
Muhsam	1926	116	48	27 sutured, 48%, 51 closure and G-E, 37%, 35 Neumann method, 63%
Kott	1926	86	47 6	suture, closure and G-E, 13 resections, 7 9%
Kuntz	1926	54	33 3	9 sutured and jejunostomy, 90%, 36 closure and G-E, 22 2%, 2 sutured, 100%, 7 resections, 0%
Oderwalt	1926	23	44	6 sutured, 17%, 15 closure and G-E, 0%, 1 resection, 0%
Iacobovici	1928	44	52	14 sutured, 79%, 14 closure and G-E, 50%, 16 resections, 32%

# PERFORATED PEPTIC ULCER IN GERMANY

TABLE I (Continued)

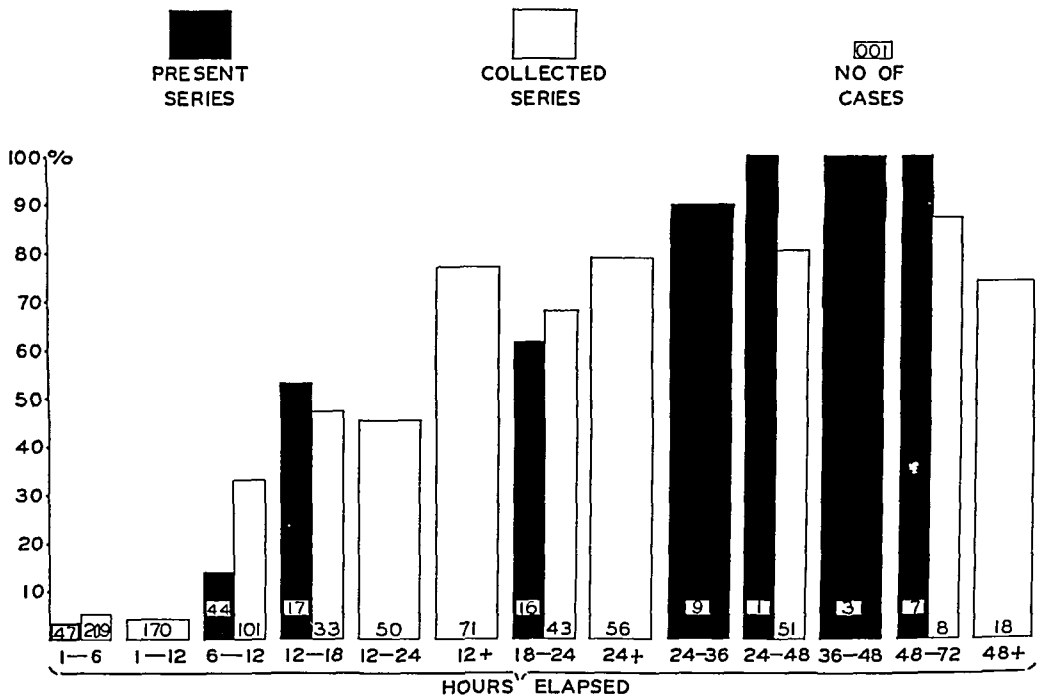
Author	Year Reported	No of Cases	Mortality Rate Percentage	Operation Used and Mortality Rate Percentage
F Schwarz	1928	58	1 7	24 sutured, 34 closure and G-E, all operated on within 6 hours
Burke de la Camp	1929	19	36 5	7 closure and G-E, 50%, 5 resections, 0%
Willich	1929	70	28 5	38 sutured, 29%, 25 closure and G-E, 20%, 7 resections, 59%
Rapant	1930	78	27	51 sutured, 2 closure and G-E, 25 resections, 12%
Zielke	1930	42	26 2	suture, closure and G-E
Kárpáti	1930	151	23 8	suture, Neumann method
Eichelter	1930	51	23 5	suture, closure and G-E, 41 resections, 17%
Present Series	1907-1918	51	50 9	19 sutured, 52 6%, 32 closure and G-E, 50%
Present Series	1918-1926	45	20	5 sutured, 60%, 16 closure and G-E, 12 5%, 24 resections, 16 6%
Present Series	1926-1931	48	16 6	7 sutured, 57%, 21 closure and G-E, 14 2%, 20 resections, 5%
Total		3,791		

That early diagnosis and subsequent immediate operation favors a successful result is demonstrated in Graph III, which shows a mortality rate of less than 4 per cent for perforations operated upon within six hours and a rapidly mounting rate which is in proportion to the delay. But one must not base a prognosis only on time elapsed from perforation to operation, it depends upon the general condition of the patient and this in turn depends largely upon the amount of peritoneal contamination that has occurred. Not infrequently, a perforation may be walled off, plugged, or covered over by a neighboring viscus for a period or a multiplicity of periods of time and thus contamination of the abdominal cavity may have occurred only for a relatively short time in a patient whose ulcer perforated twelve to twenty-four hours previously. It is such intermittent patency that makes feasible radical surgical procedures on many patients who would be classed as hopeless risks were the prognosis dependent on time elapsed alone.

The mortality rate percentages for any given operative procedure in the present series and in the collected cases are likely to lead to false deductions (Graph IV). No one doubts that closure by simple suture of the perforated ulcer is the easiest and quickest operation to perform and offers the best chance of bringing the patient successfully through the immediate threatening complications, but in most German clinics this operation has usually been performed only on patients who have been in extremely bad condition and more radical operations were reserved for patients who have



been fair to good risks. Thus the mortality rate percentage attending this simple operation is very high, 58 per cent in the present series, and 50 per cent in the collected series (Graph IV). The only reported series in which simple suture of the perforation was done in all cases were those of Seidel and Cukor, whose mortality rates were 28 per cent and 29.5 per cent, respectively (Graph IV). It would be unfair to depreciate the value of simple closure on the basis of these two old and relatively small series. But simple suture of the perforation did not often cure the almost ever-present gastritis or additional ulcers, so the German surgeons soon began adding a gastroenterostomy. As gastroenterostomy was no doubt performed on patients who were better risks, it was accompanied by a lower



PERCENTAGE MORTALITY RATES ACCORDING TO  
TIME ELAPSED FROM PERFORATION TO OPERATION

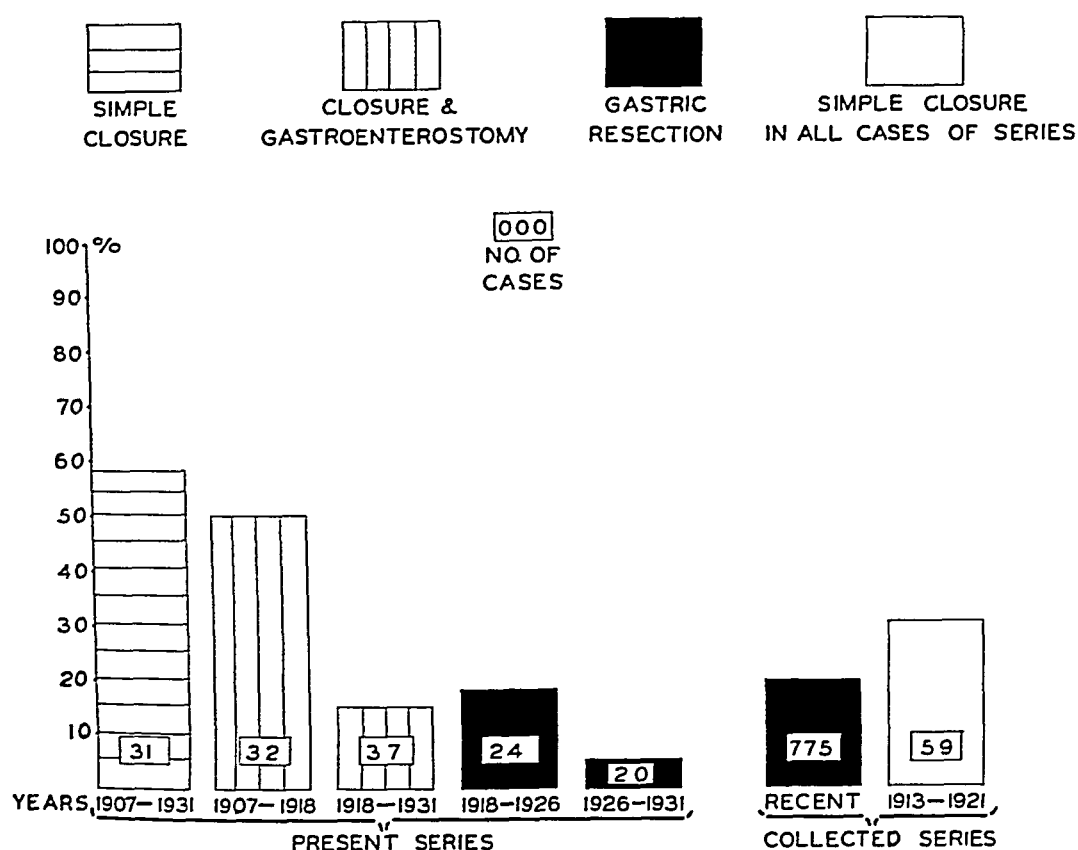
GRAPH III—Illustrates that the mortality rate per cent increases in proportion to the number of hours elapsed from the time of perforation to that of operation

mortality rate and for a while was considered the operation of choice. It will be noted that in the more recent group (1918-1931) of the present series (Graph IV), it is attended by a mortality rate of only 13.8 per cent. Apparently, this procedure resulted in more permanent cures, but many German surgeons pointed out the danger of leakage from the closed perforation and hæmorrhage from other ulcers and objected to the non-removal of the frequently diseased ulcer-bearing portion of the stomach. Ultimately, a high percentage of the gastroenterostomized patients were reported to have required re-operation for gastrojejunal ulcers or non-healed or recurring peptic ulcers.

## PERFORATED PEPTIC ULCER IN GERMANY

Before the World War, partial gastric resection had become the method of choice in the treatment of non-healing, non-perforated peptic ulcer, and following the war its use in the treatment of perforated peptic ulcer became popularized. Gastric resection constitutes about one-fourth of the major surgery done in Germany, and, therefore, most German surgeons do this operation skilfully and almost routinely in from forty to sixty minutes. It was found that gastric resection was technically easier to do in most perforated ulcer cases than in elective non-perforated ones, the majority of which are made difficult by the presence of adhesions or penetration of the ulcers into a neighboring viscus.

That gastric resection in patients with perforated peptic ulcer is attended



MORTALITY RATE PERCENTAGES IN DIFFERENT TYPES OF OPERATIONS

GRAPH IV —Shows the number of simple sutures, closures with gastroenterostomy, and partial gastric resections performed in different periods of years and the mortality rate percentages in the present series. A collected series of partial gastric resections and two in which simple suture was performed in all cases are also shown.

by a remarkably low mortality rate is undeniable. The mortality rate in 775 collected cases is only 18.2 per cent (Graph IV, Table II). This is probably due in part to selection of the better risks for gastric resection, but in 156 collected cases in which selection is admitted the mortality rate is only 5 per cent (Table II). The mortality rate percentages for gastric resection in the present series are remarkable in that there is little evidence of selection of cases. In the twenty-four gastric resections done in the period from 1918 to 1926, the mortality rate was 16.6 per cent, but in the group

of twenty done in the period from 1926 to 1931, it was only 5 per cent (Graph IV) In this latter group, the average number of hours elapsed between perforation and operation was nine, which is exactly the same as that for the 1918-1931 gastroenterostomized group (Graph IV) in which there was a mortality rate of 13.8 per cent As previously mentioned, the condition of the patient is not governed entirely by the number of hours elapsed since perforation The average age of the patients on whom a resection was performed was thirty-six and a half years, whereas the gastroenterostomized patients were five and a half years older This difference in age does favor the prognosis in the resected cases, but nevertheless this and the other records mentioned clearly indicate the speed and the skill with which gastric surgery is done by the German and Austrian trained surgeons Many more series with such low mortality rates will probably justify the institution by the European surgeons of routine gastric resection in all good risks when perforation has occurred in a chronically diseased stomach or

TABLE II

*Collected Series of Partial Gastrectomies and Mortality Rate Percentage for Each Evident Selection of Good Risks Is Indicated*

Author	Number of Cases	Mortality Rate Percentage
Willich	7	59
Hromada	10	40
Iacobovici	16	32
Cukor	12	33
Muller	17	29
Riese	44	25
Bagen	84	25
Zoepfel	20	25
Wolff	55	21
Radoievitch	150	18.7
Paugger	89	18.8
Eichelter	41	17
Brütt	55	14.5
Schmidt	19	15.8
Rapant	25	12 —all operated upon within 6 hours
Panek	36	9 —selected
Kott	17	6 —selected
Oderwalt	23	4.4 —all operated upon within 8 hours
Schwarz	12	0 —selected
Kuntz	7	0 —selected
Friedmann	10	0 —all operated upon within 12 hours
Burke de la Camp	5	0 —selected
Richard	21	0 —all operated upon within 6 hours
Present Series, 1918-1926	24	16.6
Present Series, 1926-1931	20	5

Total 819—of which 208 appear in Table I  
206

duodenum The usual gastric resection performed is a modification of the Billroth II or the Polya operations which remove or "exclude" all ulcers present and are subsequently attended by only a 2 per cent or 3 per cent occurrence of marginal ulcers in elective cases The simpler procedures do not eliminate the danger of leakage or hæmorrhage and have been subsequently attended by a high incidence of unhealed or recurring ulcers that later required resection in the presence of difficulties which raise the mortality rate considerably for so-called elective cases

SUMMARY—One hundred forty-four cases of perforated peptic ulcer personally collected in the Schmieden Clinic are analyzed with 4,258 (1897–1931) cases obtained from the German literature The condition of the patient and not the period of time elapsed from perforation to operation determines the prognosis, which is usually more favorable in patients under forty years of age The system of practice of medicine in Central Europe is given a large part of the credit for decreasing the mortality rate from 68 per cent in 1897 to approximately 17 per cent for the present time As simple closure of the perforation was reserved for patients who were poor risks, the mortality rate (50 per cent) percentage accompanying it is higher than it is for gastroenterostomy (13.8 per cent) Both of these procedures which do not remove the usually present chronically diseased ulcer-bearing portion of the stomach are rapidly giving way to partial gastric resection, which is so successful in the treatment of elective cases of peptic ulcer

The institution of routine partial gastric resection for perforated peptic ulcer in Central European patients who are good risks is probably justified because (1) Peptic ulcers are multiple in about 30 per cent of all patients who have a perforation, (2) gastritis, atrophic, hypertrophic, or ulcerative, is usually present in the ulcer-bearing area of the stomach, (3) the pathology present cannot be evaluated, particularly in the duodenum, by inspection and palpation alone, (4) gastric resection is performed by most German and Austrian trained surgeons in from forty to seventy-five minutes, (5) the mortality rate for patients who are good risks is not over 5 per cent, (6) gastric resection for perforated ulcer is usually technically easier than it is in elective cases of peptic ulcer, (7) the simpler procedures do not always cure the ulcer or alleviate the gastritis present and are frequently followed by recurrences of peptic ulcer or the development of a marginal ulcer Gastric resection which is usually required in these failures is frequently extremely difficult to execute and is usually accompanied by a high mortality rate percentage for so-called elective cases

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# ACUTE PERFORATED GASTRIC AND DUODENAL ULCERS

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Two hundred twenty-seven cases of acute perforated gastric and duodenal ulcers have been operated upon at the Detroit Receiving Hospital during a period of thirteen years (January, 1920, to January, 1933) In every case at operation, stomach contents were found freely escaping from the ulcer into the general cavity of the peritoneum No subacute or chronic perforated ulcers are included in this report Of these 227 cases operated upon for acute perforated ulcer, 172, or 75.77 per cent, recovered, and fifty-five, or 24.22 per cent, died The results of the history, examination, operative findings and immediate outcome are herewith tabulated

*Sex Incidence*—It may be noted (Table I) that men were more prone to perforated ulcers than women Of the four females in this series, three were correctly diagnosed on admission, whereas in the fourth instance a diagnosis of pelvic inflammatory disease was made One of the perforations among the women was of the gastric variety while the other three were duodenal All recovered except one of the cases of perforated duodenal ulcer

TABLE I

*Sex Incidence*

Sex	Number	Percentage
Males	223	98.23
Females	4	1.76

*Age Incidence at Time of Operation*—It may be seen (Table II) that the majority of perforations occurred in the middle years of life The average age was thirty-seven years, the five youngest all being nineteen, and the three oldest being respectively sixty, sixty-one and seventy (died) years old There was a sharp drop in the frequency of perforated ulcers in those over fifty years of age

TABLE II

*Age Incidence at Time of Operation*

Age	Number	Percentage
Under 20 (all 19)	5	2.20
20-30	61	26.87
30-40	82	36.12
40-50	54	23.78
50-60	22	9.69
60-70	3	1.32

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*Nationality*—As far as nationality (Table III) is concerned, our records seem to show that no race is exempt from ruptured ulcers. Some of those stating they were Americans were naturalized and others were children of foreign-born parents. Of especial interest, however, is the fact that thirty of these patients were Negroes.

TABLE III

*Nationality*

United States—white	115	Scotch	11
Colored	30	Irish	7
Canadian	19	English	5
South European	12	Jewish	4
Polish	11	Others	13
			227
Total			

*Occupation*—Statistics regarding occupation (Table IV) were gathered but found to be somewhat misleading. While fifty-six stated they were unemployed, it was known that others belonged in the same category. A glance at the list will readily show that very few had any steady employment and that none were in the private-patient class. This is to be expected in a list of patients reported from a city hospital, rarely admitting others than the less fortunately situated. Among those listed as having unclassified employment there were one farmer, one sailor, one soldier, one fireman and two railway workers.

TABLE IV

*Occupation*

Unemployed	56	Auto drivers	13
Laborers	47	Clerks	13
Auto industry	28	Machinists	9
Small wage-earners	23	Unclassified	24
Domestics	14		
			227
Total			

*Seasons of the Year in Reference to Perforations*—Seasonal occurrences of chronic gastric and duodenal ulcer symptoms have long been emphasized. Changes of weather in the spring and fall months have been thought to increase the symptoms. Likewise, many reports of ulcer perforations have shown them to be more common during the same periods. However, our table (Table V) shows that perforations of ulcers increased in frequency during the spring, reached a peak during the summer, gradually decreased in number during the autumn, and reached the lowest rate in the winter months. In this climate dietary indiscretions are more frequent in this class of patients during the summer. Also it may be noted from our table that the death rate was lowest in winter and highest in fall and summer.



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TABLE V

*Seasons of the Year in Reference to Perforations*

Season	Recovered	Died	Total	Percentage Died
Winter	38	7	45	15 4
Spring	48	14	62	22 5
Summer	48	18	66	27 2
Fall	38	16	54	29 6
Totals	172	55	227	

*Year of Perforation Comparing Total Number Operations Performed with Number Operated on for Perforated Ulcer*—In the following table (Table VI) we have endeavored to ascertain the frequency of operations performed on acutely perforated ulcers of the stomach and duodenum as compared with the total number of operations done each year in this hospital. The total number of operations have not materially increased, especially during the past ten years. However, there has been a steady increase in the number of operations performed each year for ruptured ulcer. For some time we thought this increase was merely apparent and due to incomplete diagnosis but statistics show the increase to be real.

TABLE VI

*Year of Perforation Comparing Total Number Operations Performed with Number Operated On for Perforated Ulcer*

Year	Total Number of Operations	Number of Operations for Perforated Ulcer
1920	763	2
1921	3,383	5
1922	3,747	10
1923	3,650	10
1924	3,524	11
1925	3,681	17
1926	3,672	21
1927	3,973	17
1928	4,228	30
1929	4,096	26
1930	4,243	24
1931	4,591	28
1932	4,410	26

*Previous History of Gastric Disturbance*—Of note (Table VII) is the fact that nearly 83 per cent gave a history of previous gastric distress. The majority (156 cases) of these had a history of stomach trouble ranging from one month to thirty years, the average duration being forty-one months. A small percentage complained of dyspepsia all their lives. A third group of twenty-five cases stated that their gastric disturbance had lasted from five to twenty-one days with an average of twelve and four-tenths days. Bloody vomitus was admitted in seventeen and was denied in fifty-three cases. Blood

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was recorded in the stools in eleven and forty-seven cases denied having had tarry stools

Fourteen per cent denied any type of gastric distress preceding the perforation Too much dependence was not placed on the denial of previous gastric troubles at the time when the patient had just undergone the agony of perforation Further questioning during convalescence frequently elicited a very definite history of chronic ulcer Death shortly after operation prevented investigation into the previous digestive history of others

TABLE VII

*Previous History of Gastric Disturbance*

Previous History	Number	Percentage
Positive	188	82 81
Negative	32	14 09
Not recorded	7	3 08
Total	227	

*History of Previous Treatment of Ulcer*—Seventeen patients (Table VIII) stated that they had taken no treatment for their ulcers in the past Twenty-four (10 5 per cent ) reported that they had had more or less regular medical treatment under the direction of a physician One perforated while on Sippy treatment in this hospital and a number had undergone several courses of medical and dietary treatment One had had an operation for chronic gastric ulcer seven years before the acute perforation Two had had perforated ulcers previously closed Seventy-seven stated they found relief in soda, diet or other self-administered remedies On their own initiative, six had taken various drugs for relief A history of previous treatment was not mentioned in the histories of 109 cases

TABLE VIII

*History of Previous Treatment of Ulcer*

Treatment	Number	Percentage
None	17	7 4
Medical	24	10 5
Soda, food, or both, etc	77	33 9
Not mentioned	109	48 0
Total	227	

*Pain*—Epigastric pain (Table IX) was the outstanding initial symptom This was sudden and agonizing in 98 6 per cent of the cases In 1 3 per cent the onset was gradual with pain becoming unbearable in from five to thirty minutes One complained of a sensation of terrific heat in the epigastrium Twenty had pain referred to the shoulders

The records state that after onset the pain remained constant in ninety-eight cases In eighteen cases it became intermittent In seven of the

latter, intermittent rigidity of the abdomen was recorded. Most of them were found to have minute perforations in the soft, recent type of ulcer. Food particles plugged the perforations in several. In two patients, the mucosal lining of the opposite wall of the duodenum protruded through the small opening and prevented the continuous escape of gastric contents.

In eight cases, severe straining or direct trauma to the abdomen preceded the pain.

TABLE IX

*Pain*

Onset	Number	Percentage
Sudden	224	98.6
Gradual	3	1.3

*Vomiting with Perforation*—Vomiting, especially vomiting of blood, is one of the rarest findings following perforation of an ulcer. Vomiting (Table X) occurred after the rupture and before the patient was operated on in a little less than half of the cases where this finding was recorded. In most of these it occurred only once or twice or was described as retching. It was recurrent in three cases, blood-stained in two cases, and described as coffee grounds in one case. In one case vomiting occurred before pain and perforation appeared, and another vomited blood fifteen minutes before the pain occurred. It was recorded as provoked in four and followed the administration of morphine in three instances.

TABLE X

*Vomiting with Perforation*

	Number	Percentage
Positive	96	42.2
Negative	48	21.1
Not recorded	83	36.5
Total	227	

*Clinical Findings*—The clinical and laboratory findings (Table XI) coupled with the salient features of the present and past histories served to attain the diagnosis. The average temperature, pulse rate, leucocyte count and white blood count in a majority of the cases showed a slight increase over normal. Collapse or shock was definitely reported as absent in 70 per cent. Intermittent rigidity of the abdomen occurred in 3 per cent of the cases and aroused suspicion of pneumonia or of lesser abdominal conditions. Obliteration of liver dullness was positive in fifty-four, negative in twenty and not reported in 153 cases. In at least 23.7 per cent of this series, absence of liver dullness was recorded.

In 131 cases, the blood was examined for the presence of syphilis. Of the twenty cases reported as positive, 75 per cent died and of the 111 cases reported as negative, 14.8 per cent died.

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TABLE XI

## *Clinical Findings*

Temperature below 99° on admission in 62 per cent
Pulse below 100 on admission in 73 per cent
Leucocytes (average 183 cases) 13,385
Polymorphonuclears (average 183 cases) 81 per cent
Constant rigidity of the abdomen in 97 per cent
Intermittent rigidity of the abdomen in 3 per cent
Liver dullness was obliterated in 23 7 per cent

*Pre-operative Diagnosis on Admission*—This table (Table XII) lists the immediate diagnoses on every one of this series of 227 cases of acute perforated gastric and duodenal ulcers. They were written down in the admitting room immediately on entrance to the hospital. Subsequently, on being put to bed, the diagnosis was corrected or a condition requiring immediate surgery was recognized and all of them were subjected to laparotomy as soon as their condition permitted.

It may be noted that 85 per cent of the cases were immediately and correctly diagnosed as perforations of gastric or duodenal ulcers. Diagnosis of other acute surgical abdominal emergencies, such as acute appendicitis (in four instances a gridiron appendectomy incision was first made), intestinal obstruction, acute pancreatitis and volvulus, brought the total requiring immediate operation to 96.9 per cent. Acute perforation may be confused with other lesions giving the symptoms of an acute surgical abdomen. Care was taken to rule out the most important non-operative or medical lesions, such as alcoholism, meningitis, pneumonia, tabetic crises, mesenteric thrombosis, and coronary thrombosis. (All of these were among the mistaken diagnoses.)

Rontgenographical and fluoroscopical examination was resorted to in a few of the last cases in the series and was found to be of assistance in the diagnosis, especially when several hours had elapsed after perforation.

It is impossible to compute the exact number of cases in which other acute intra-abdominal conditions were primarily diagnosed as acute perforated ulcers but this mistake was relatively rare. Suffice to say that such a mistaken diagnosis was infrequent with an admitting doctor who had ever seen an acute ruptured ulcer before.

TABLE XII

## *Pre-operative Diagnosis on Admission*

	Number
Cases diagnosed correctly on admission	193
Cases diagnosed incorrectly	34
Considered requiring immediate surgery	27
Cases wrongly diagnosed—medical	7

*Hours Elapsing Before Operation*—The length of time that had elapsed between the onset of the attack and the operative treatment (Table XIII)

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was estimated and varied from eighty minutes to four days. In two instances the interval could not be determined. There was a constant steady increase in the mortality rate with the passing hours.

TABLE XIII  
*Hours Elapsing Before Operation*

Hours	Recovered	Died	Total	Mortality, Per Cent.
Under 6	92	11	103	10.6
7-12	57	11	68	16.1
13-18	11	11	22	50.0
19-24	7	7	14	50.0
Over 24	5	13	18	72.2
Not determined	0	2	2	100.0

*Location of Ulcer* —In reference to the location of the perforated ulcer this study (Table XIV) was of interest in regard to frequency and mortality. The majority of perforated ulcers in the series occurred in the duodenum and in this location the percentage of recovery was the best. In some instances the anatomy in the region of the pylorus was so distorted by the pathology presented that it was impossible to differentiate between gastric and duodenal ulcers. These are included in this table with the true pyloric ulcers. Perforated gastric ulcers comprised nearly one-quarter of the cases. That perforations of ulcers of the stomach do occur quite frequently is borne out by the tabulation below. In general, perforation of an old large calloused ulcer was found with a history of long gastric disturbance, a recent, small, soft ulcer was found when the history of previous dyspepsia was short or entirely lacking. In one case multiple fine perforations in a local area were encountered.

TABLE XIV  
*Location of Ulcer*

Location	Recovered	Died	Total	Percentage Died
Duodenum	104	28	132	21.2
Stomach	42	13	55	23.6
Pylorus	26	13	39	33.3
Gastrojejunum	0	1	1	100.0
Totals	172	55	227	

*Size of Perforation* —Consistently (Table XV) the larger the perforation the poorer was the prognosis for the mortality was three times greater with the large perforations.

TABLE XV  
*Size of Perforation*

Type	Size	Number	Died
Small	Up to 3 mm	109	16
Large	3 to 3 cm	48	21
Size not recorded		70	18
Totals		227	55

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*Escaped Gastric Contents*—The mortality was higher (Table XVI) where large amounts of fluid or thick gastric contents had escaped. In the presence of large fluid accumulations there appeared to be an inability or on the other hand, little attempt at closure by adhesions to other structures. Large food particles free in the abdominal cavity increased the gravity of the prognosis. Various terms such as bile-stained, pea-soup, milky, watery, turbid, green and mucoid were used to describe the escaped gastroduodenal contents. Bacteriological examination was resorted to in but seven cases. The smears were all negative. The cultures showed a very few streptococci in one and coli in another instance.

TABLE XVI  
*Escaped Gastric Contents*

Type	Number	Died
Gastric fluid	42	6
Food particles	6	4
Grapes	2	2
Blood stained	3	2
Not stated	10	4
Miscellaneous	164	37

*Age Incidence of Deaths*—In reference to age (Table XVII) the mortality percentage remained nearly stationary for all ages between nineteen and sixty years.

TABLE XVII  
*Age Incidence of Deaths*

Age	Number	Percentage
Under 20	1	20.0
20-30	14	23.3
30-40	19	24.6
40-50	13	25.4
50-60	6	23.8
60-70	2	66.6

*Time of Occurrence of Death after Operation*—The deaths (Table XVIII) occurring in the first twenty-four hours (36 per cent) can be ascribed to the overwhelming nature of the attack, to anæsthesia, to operative trauma, or a combination of all three factors. The cause of death of the remaining two-thirds was peritonitis, later complications and secondary operations in otherwise severely handicapped individuals.

TABLE XVIII  
*Time of Occurrence of Death after Operation*

	Number		Number
On Table	3	2-3 weeks	3
24 hours	17	4-8 weeks	3
2-6 days	16	Not stated	3
7-14 days	10		—

*Cause of Death*—In determining the cause of death (Table XIX), it was found that general peritonitis was present to a more or less degree in all cases. Death following secondary operations for post-operative complications occurred in six instances. However, from the pathological standpoint, general peritonitis was the outstanding finding in thirty cases. The other causes of death reported, while condensed or limited to one finding, are fairly accurate as post-mortem was obtained in nearly every instance.

TABLE XIX

*Cause of Death*

Name	Number	Following operation for complications	
General peritonitis	30	such as	
Shock	7	Incisional hernia	2
Pneumonia	6	Intestinal obstruction	1
Collapse of lung	2	Duodenal fistula	1
Liver abscess	1	Empyæma	1
Pulmonary œdema	1	Pelvic abscess	1
Myocarditis	1		—
Infarct lung	1	Total	55

*Mortality in Reference to Anæsthetic Used*—The anæsthetic (Table XX) employed was one of many factors considered in reference to the mortality rate. It must be stated that nitrous oxide, local and their combinations were administered to extremely bad-risk patients, which accounts for the poor results with their use. In the good-risk patients, combination anæsthetics including ether or spinal anæsthesia were used. Spinal anæsthesia alone, during the more recent years covered in this series, has become the anæsthetic of choice for operations on perforated gastric and duodenal ulcers. This has been in spite of the fact that one of the three deaths occurring on the table had received spinal anæsthesia.

TABLE XX

*Mortality in Reference to Anæsthetic Used*

Type	Anæsthetic		Died	
	Number	Percentage	Number	Percentage
Spinal	72	29.6	8	12.5
Gas-ether	62	28.2	17	26.23
Ether	83	37.5	23	28.4
Gas	7	3.2	4	57.0
Local	2	9	2	100.0
Gas-local	1	4	1	100.0

*Type of Operation Employed*—The type of operation (Table XXI) employed depended upon the condition of the patient, the extent of pathology and the degree of obstruction. Closure alone of the perforation was done in 188 cases (75 per cent). By closure is meant simple closure, closure with oversewing, closure with neighboring omental grafts or combinations of the three.

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Excision of the ulcerated area and closure was done in thirty-six cases, with the lowest mortality rate in the series. In eight of these, the closure was effected by pyloroplasty (Horsley, 4—Judd, 4), with recovery in each instance.

Closure with added gastroenterostomy was employed in twenty-two cases, with a mortality rate slightly less than by simple closure and slightly greater than by excision and closure. As this addition lengthened the operative time, it was rarely used in the more seriously sick. Gastroenterostomy was not employed in any of the ruptured gastric ulcers.

In a series of 132 operations for acute ruptured ulcer since June, 1926, gastroenterostomy was done but once. The operative mortality of this group was 21.3 per cent as compared with 31.2 per cent in those done previous to this date when most of the gastroenterostomies were performed.

Closure of the ulcer with extramucosal excision of the anterior half of the pyloric sphincter has not been employed. Laparotomy under local anaesthesia and simple insertion of a drain was not used. None of the larger operations such as pylorectomy or partial gastrectomy has been done for acute perforated ulcer. It seems that more is to be gained by reducing the operation to a minimum than by extending it to a maximum.

Drainage was employed in 203 cases, not used in fifteen and not recorded in nine cases. One of the fifteen cases not drained, died. No macroscopical food debris was seen in those not drained. One to three drains were employed in most instances. Most of these were of the suprapubic variety, some drained Morrison's pouch and a few were brought directly through the incision.

In addition to the operative work for perforated ulcer, the appendix was removed in sixteen cases, the gall-bladder in one and a jejunal catheter was used in one case.

The immediate post-operative care for all was the accepted expectant treatment for peritonitis. On the second or third day, warm water by mouth was started. This was followed by liquid diet and later by a bland type of soft diet.

The average number of days spent in the hospital by the 172 patients who recovered was twenty-one days.

TABLE XXI

*Type of Operation Employed*

Type of Operation	Number Operated	Number Died	Percentage Died
Simple closure	168	41	24.40
Excision ulcer and closure	36	8	22.22
Closure with gastroenterostomy	22	5	22.72
Gastrojejunostomy repair	1	1	100.00
Totals	227	55	



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### SUMMARY OF RESULTS

(1) A consecutive series of 227 cases of acute perforated gastric and duodenal ulcers operated on is reported. Less than 2 per cent were females, the average age was thirty-seven years, many different nationalities were represented, nearly all had no steady employment.

(2) Perforations increased in frequency during the spring, reached a peak number in the summer, gradually decreased in number during the autumn and reached the lowest rate in the winter months.

(3) As compared with the total number of operations done in this hospital during the thirteen-year period covered in this report, operations for perforated gastric and duodenal ulcers have increased in frequency nearly threefold.

(4) A definite history of chronic gastric ulcer was obtained in more than four-fifths of the cases. Ten per cent had had medical management.

(5) Severe pain in the epigastrium was the outstanding initial symptom. Vomiting, best described as retching, occurred once or twice in about one-half of the cases. Bloody vomitus was conspicuous by its rarity.

(6) In the time permitted for diagnosis, the clinical findings were of far greater comparative value than the laboratory findings. Among the latter, fluoroscopical examination is the exception. On admission to the hospital, 85 per cent were immediately and correctly diagnosed.

(7) The mortality increased directly with the size of the opening, the amount and extent of the peritoneal soiling and the time allowed to elapse between rupture and operative treatment.

(8) Frequency of perforation, according to location of the ulcer, was respectively duodenal, gastric and pyloric. Recovery was in the same sequence.

(9) The recovery percentage remained nearly stationary for all ages between the second and sixth decades. Thirty-six per cent died within the first twenty-four hours after operation. General peritonitis was the most frequent cause of death followed by shock, pneumonia and complications requiring secondary operations.

(10) In reference to mortality, morbidity and operation itself, spinal anaesthesia was the most satisfactory anaesthesia employed.

(11) The type of operative treatment employed while individualized was confined to simple closure, excision and closure, and closure with added gastrojejunostomy. Simple closure alone was employed in the last 132 cases in this series. In this group, there was a 10 per cent reduction in mortality rate. In general, the greater the risk presented at operation, the less was done.

(12) Of these 227 cases operated upon for acute perforated ulcer, fifty-five or 24.22 per cent, died and 172 or 75.77 per cent, recovered.

## TOTAL GASTRECTOMY

BY CLYDE AUGUSTUS ROEDER, M D

OF OMAHA, NEB

I DESIRE to report, for the first time, three cases of total gastrectomy performed by me and to offer a bibliography which in my opinion is more or less complete to date \*

According to the literature at my disposal, Pean (*Gaz de Hop Paris*, vol lii, p 473, 1879) was the first to have performed a partial gastrectomy upon a human being, but with an operative mortality T Billroth (*Wien med Wchnschr*, vol xxxi, p 161, 1881), according to the literature, is credited with having performed the first successful partial gastrectomy The principles of gastric surgery, according to M R Reid, originated with Czerny and Kaiser (*V Beitr z Oper Chir*, pp 93-160, 1878) whose work was carried out upon dogs

The operation of total gastrectomy designates the removal of all of the stomach including a portion of the duodenum and œsophagus It must be differentiated from the operation which leaves any portion of the upper end of the stomach and which is known as subtotal gastrectomy Many authors have reported cases of gastrectomy which were in reality subtotal resections, a grave error in recording The term gastrectomy should, to be correctly used, indicate a total removal of the stomach, and all lesser removals should be known as gastric resections

The first total gastrectomy upon a human being was quite likely performed by Phineas Connor of Cincinnati in 1884, but his patient was moribund at the time and unfortunately did not live through this heroic effort No further reports can be found until 1897, when Carl Schlatter recorded a successful total gastrectomy, the patient living about fourteen months There have been, according to all the reports my assistant, Charles E Gurney,

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\* Relative to bibliographies, I feel that we should have an international bureau for bibliographical compilation and conducted expertly and impartially In the United States the Surgeon-General's library and the Cumulative Index of the American Medical Association have been and still are most useful, but even with their use, authors are confronted with the expenditure of too much time and expense A bibliography should be complete and fair and begin at the beginning of medical records It is a wasteful effort of an author's or his assistant's time to endeavor to gather together all of the reports to date, and such translations are too uncertain It is a worthy task for a bureau of technicians and translators of international function and could easily be supported by the world's medical authors When an author, as I in this present report, desires to present an article which should be accompanied by a complete bibliography, such a bureau should be at his service The bibliography imperfect as it may be, is a far greater effort than the article itself An international bibliographical bureau should keep all references up to date so that they may be furnished on a moment's notice and at very little cost

and I could find, a total number of eighty-five total gastrectomies performed, not including the three cases I am reporting in this article which make in all eighty-eight, with an operative mortality of forty-four including the two operative deaths in my series of three cases. I am including as surgical deaths those following the operation as long as sixty days. The most common causes of death were peritonitis and "shock." Probably some of the early deaths from shock were due to hæmorrhage and the later ones reported as due to shock were due to virulent infections. Stomatitis and diarrhœa were troublesome complicating factors and are worthy of mention.

In a report by Finney and Rienhoff (*Arch of Surg*, p 156, January, 1929) most of the recorded cases were tabulated. To those I have been able to add ten cases which those authors did not include.

In a personal communication from Rienhoff of July 27, 1932, he states that he and Finney have done two total operative removals of the stomach. In three other instances so small an amount of the stomach was left that it was completely included with the sutures, resulting in a total destruction or removal, at least functionally, of the gastric segment. Waltman Walters in a letter dated April 19, 1932, reports a total of three cases, the last dying on the fifth post-operative day of bronchopneumonia. P. Peugniez (*Bull Acad de Med*, Paris, vol xcii, p 831, 1924) as recorded by Finney and Rienhoff, removed all of the gastric mucosa and left only a small portion of the muscular and peritoneal layer adjoining the œsophagus (Goepel's procedure). This functionally resulted in a total gastrectomy.

The operation of total gastrectomy is increasing in frequency due probably to an increasing number of operators, safer anæsthesia, a wiser choice of the patient to be operated upon and more efficient pre-operative and post-operative treatment. Recurrences following resections of the stomach are in the vast majority of instances found to be in the region of the remaining portion of the stomach in addition to metastases to the liver, retroperitoneal lymph-nodes and more remote regions. This naturally compels one to wonder if a total gastrectomy, in preference to a subtotal, would have prevented a certain number of such recurrences.

In the Proceedings of the Staff Meetings of The Mayo Clinic of December 30, 1931, Adrian Verbrugghen reported a study of the intramural extension of gastric carcinomatous cells. His result showed that at least four centimetres of apparently healthy stomach wall should be removed with the primary growth. Since most of the growths are on or near the lesser curvature of the stomach, one may safely conclude that, excepting those small growths around the pylorus, whenever a portion of the lesser curvature is left a local recurrence is quite likely to occur.

The indications for a total gastrectomy depend upon the judgment and experience of the operator and the local and general condition of the patient. The high mortality rate is the principal contra-indication, while the post-operative life and blood complications are secondary in importance and particularly since primary anæmias are now treated with such satisfactory results. The

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patient who recovered in my series of three had an occasional nausea the first week following the operation and has had hunger sensations ever since. The sensations of nausea and hunger, therefore, are not exclusively connected with the stomach. F G Mann (Proc Staff Meetings of Mayo Clinic, vol xiv, p 294, 1929) after performing total gastrectomies in dogs, found them with hunger sensations and able to vomit.

The duration of life following total gastrectomies, and those operations in which a very small rim of cardiac end of the stomach is left—practically a total removal, seems to depend largely upon the development of a primary anæmia. Finney and Rienhoff found the longest period to be four years and eight months. In a personal communication by letter dated July 4, 1932, from A W Mayo Robson, he stated that a patient is now living over thirty

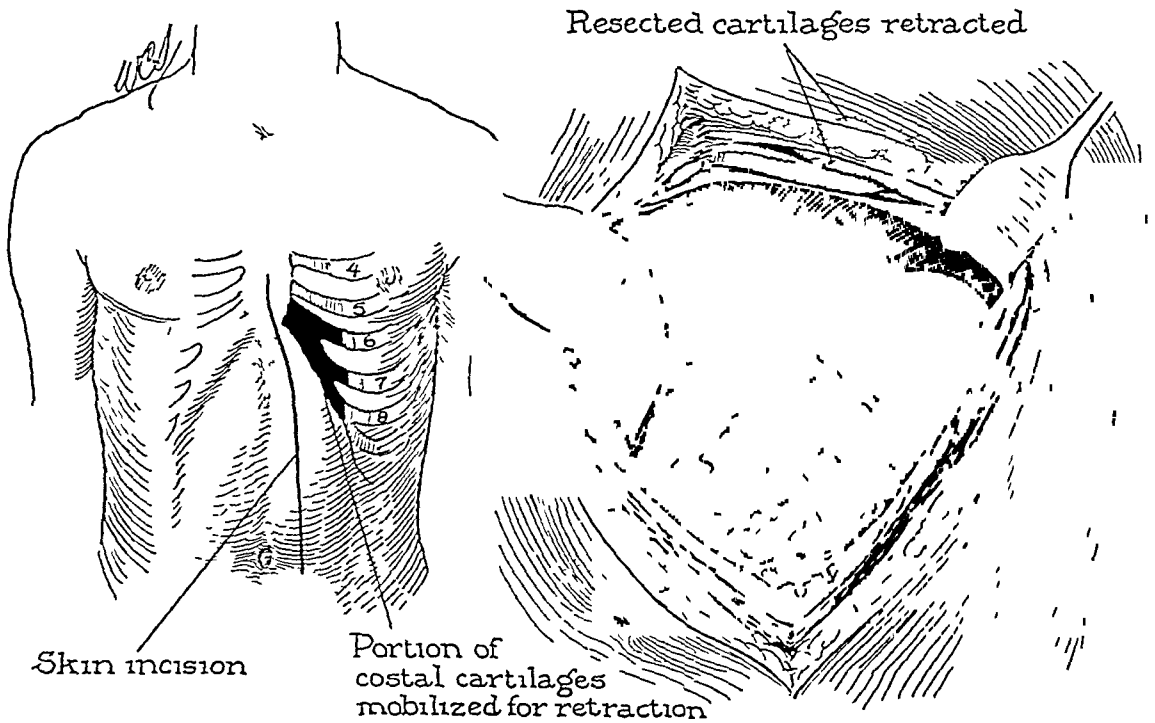


FIG 1.—Skin incision extends over lower end of the sternum, which allows dissection to the left over adjoining costal cartilages. Shaded area indicates the amount of cartilage cut free from its bed which allows further retraction to the left, exposing the cardiac end of the stomach.

years following an almost complete total gastrectomy. With proper food, hydrochloric acid, stomach extracts and blood-supporting treatment, the length of life may be greatly prolonged. During immediate post-operative treatment, pre-digested food, hydrochloric acid and pepsin may be advantageous.

*Technic*—The technic I devised for exposing the cardiac end of the stomach and for producing a larger pouch for the reception of food from the œsophagus was developed without knowing that George Marwedel and Victor Hoffman had preceded me. Marwedel, in 1903, reported a technic by mobilizing a portion of the right costal cartilages for exposing the liver (Zent fur Chir, vol xxx, p 938, 1903) which procedure he later performed upon the left side for exposing the lower end of the œsophagus. In 1922, Victor Hoffman (Zent fur Chir, vol xlix, p 1477, 1922) described

a long entero-anastomosis below the union with the œsophagus with the idea of presenting a greater food pouch. The technic of Marwedel and Hoffman I have used three times, not knowing of their priority, and I feel these

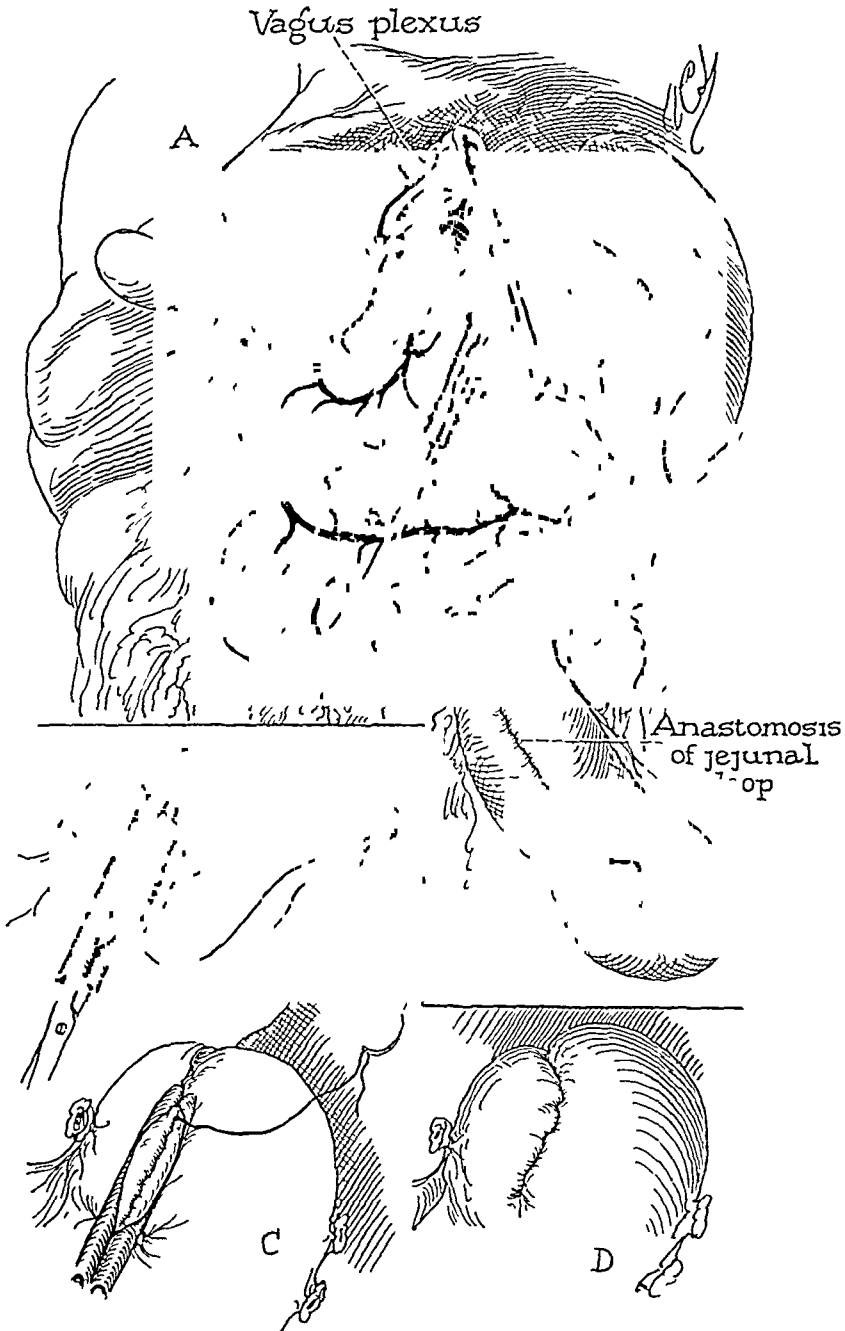


FIG 2 — A' shows the œsophagus detached from the stomach. Note the blood vessel to the lower end of the œsophagus which should be preserved if possible to prevent sloughing. Note the jejunal loop united by a six inch anastomosis and stitched to the transverse mesocolon to prevent traction and herniation.

procedures are worth considering. In elevating the cartilages there is danger of opening the pleura, an accident which happened with my second case.

The operation (Figs 1, 2, 3 and 4) is preferably done under spinal

# TOTAL GASTRECTOMY

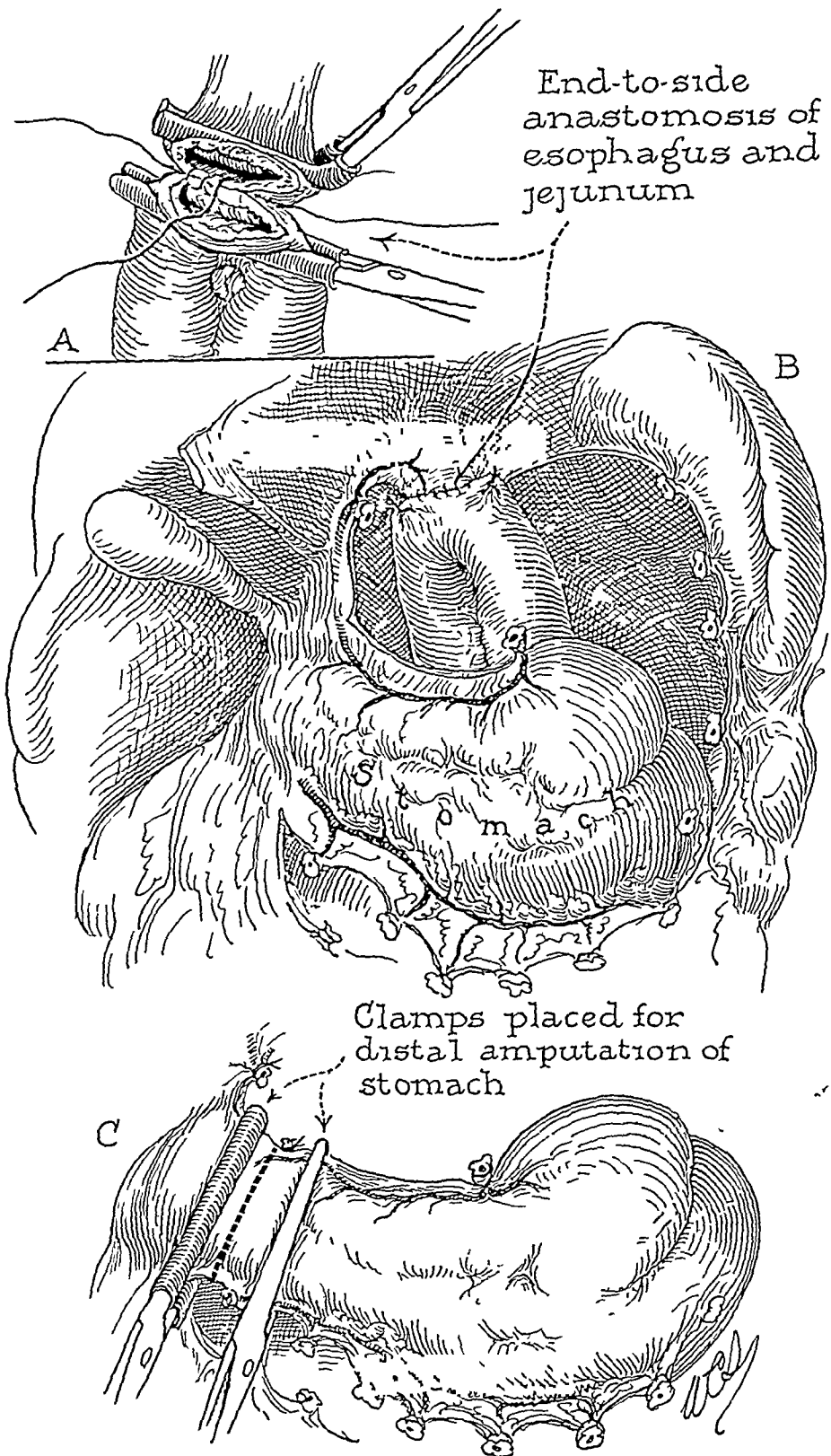


FIG 3—Rarely can the duodenum be joined to the œsophagus, therefore, an end to side œsophago-jejunal anastomosis is generally indicated. Note the suture on each side of the union which prevents acute angulation. The operation may be stopped here provided a small rubber tube, for the escape of gas, is stitched into the stomach and brought out through the abdominal or stab incision. The adjacent stomach walls should then be sutured to the abdominal peritoneal layer surrounding the tube.

anæsthesia, which gives greater exposure After the anastomoses are completed, the operation may be stopped and the stomach removed from the

duodenum and the blood-vessels during an operation about ten days later In case this two-stage procedure is decided upon, it may be advisable to insert a tube into the stomach for drainage of gas and fluids out through the closed incision If the transverse colon and its mesentery appear to weigh heavily upon the jejunal loop, supporting sutures of some kind should be inserted I feel that my second case would have lived had I taken such a precaution

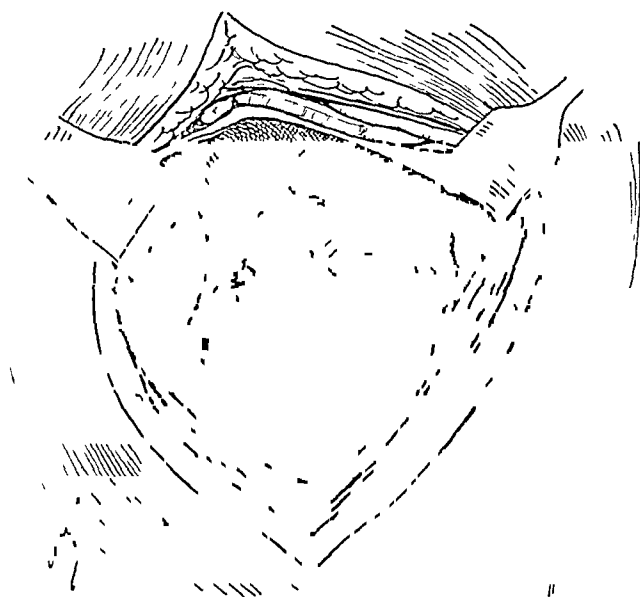


FIG 4—The operation completed Careful notation should be made of the possible traction on the anastomosis by a sagging transverse colon If this appears probable the central portion of the colon should be stitched to the anterior abdominal wall

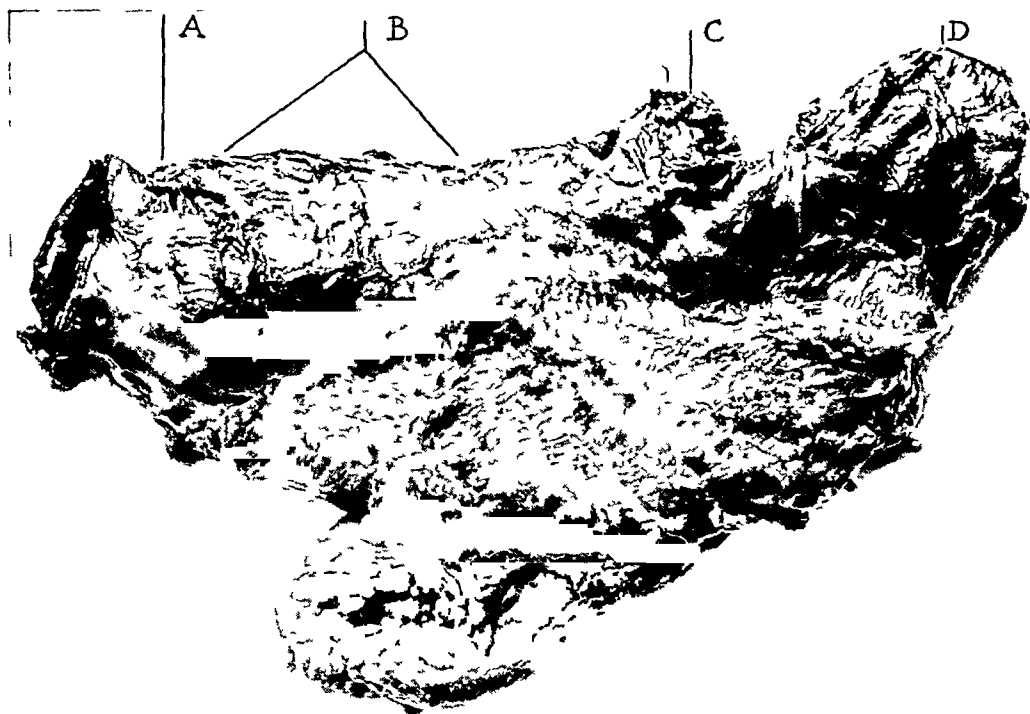


FIG 5—(Case II) The stomach mass after removal (A) Pylorus (B to C) Malignant mass (D) œsophagus

#### CASE REPORTS

CASE I (No 4029)—Male, aged fifty-two operated upon at the Wise Memorial Hospital on October 1, 1922 Gastric symptoms had been present for ten years or more

## TOTAL GASTRECTOMY

An indefinite mass was felt in the epigastrium and X-ray showed a filling defect in the pre-pyloric region. There was no free hydrochloric acid in gastric contents. General examination warranted an exploration, during which the malignant growth was found involving the pre-pyloric area and apparently extended to within five centimetres of the cardiac orifice. A small mass of malignant lymph-nodes was found within the lesser omentum but no other signs of metastases were noted. A total gastrectomy was performed under ether anaesthesia and a loop of jejunum was sutured to the oesophagus with an entero-anastomosis below. The patient died in sixty-eight hours from a clinical picture resembling pulmonary oedema and on inspection of the operative field there was disclosed nothing of significance. Both pleural cavities were inspected through the diaphragm and each contained about 300 cc of serous fluid slightly blood-tinged.

The specimen was examined by the attending pathologist, Dr A. S. Rubnitz, who recorded it as carcinoma with lymph-node metastasis.

CASE II (No 9192) —Female, aged sixty-one, was operated upon at the Immanuel Hospital on February 12, 1931. Gastric symptoms had been present for one year with a definite movable mass in the epigastrium. There was no free hydrochloric acid and a



FIG 6 —(Case III) The stomach mass after removal. Indentation on anterior wall near lesser curvature is opposite crater in mass involving posterior wall.

secondary anaemia of about 50 per cent of the normal was present with a loss of weight of about 25 per cent of normal. The X-ray indicated a malignant pre-pyloric mass apparently not adhered to any marked degree. Under spinal anaesthesia a total gastrectomy was performed and the jejunum was sutured to the oesophagus with an entero-anastomosis below. The patient died five days after the operation and only a local inspection was permitted (Fig 5). The anastomosis was intact but a loop of ileum below the transverse mesocolon and about six inches in length had become gangrenous, probably due to the weight and drag upon its blood supply by the transverse mesocolon and transverse colon. This is a very important point to keep in mind following total gastrectomies. The patient died of peritonitis from perforation of this gangrenous loop.

CASE III (No 38466) —Male, aged fifty, operated upon at the University of Nebraska Hospital on April 9, 1932, where I was assisted by the house surgeon, Willis D. Wright. Gastric symptoms had been present for the past six months, and no definite mass was palpable in the epigastric region. The X-ray examination disclosed a large crater with possible perforation on the posterior wall near the lesser curvature. Free hydrochloric acid was present in the gastric contents, and other laboratory and physical tests were negative except for a loss of weight of 20 per cent and some loss of strength. Under spinal anaesthesia and carbon dioxide inhalation the stomach was found to contain a hard mass with a crater two centimetres in diameter well up on the posterior wall.



near the lesser curvature. No glandular involvements nor metastases were demonstrable. Since the mass felt typically malignant and extended to within a few centimetres of the cardiac orifice, a total gastrectomy was performed (Fig 6). The jejunum was united with the œsophagus, end-to-side, and a large entero-anastomosis, as in Cases I and II, was added below.

The post-operative course (Fig 7) was uneventful and the blood-picture with a particular study of the reticulocytes, remained normal during the several months the patient was under observation. About one week after the operation he had sensations of hunger and nausea. A report two months after the operation stated that he felt well and was working at his previous occupation that of a paint contractor. Dr J C Kildebeck, Emerson, Nebraska, his physician, reported on July 26, 1932, that the patient

was feeling very well and was eating only three times a day and the same amounts of all kinds of food such as he consumed before he first became ill. The blood picture of this patient—cellular and chemical—shall be followed regularly and reported if possible at a later date. This patient has definitely proven that the sensations of hunger and nausea occur without a stomach.

Sections of the mass surrounding the crater disclosed no malignant cells and the cake-like feeling mass may have been due to inflammatory changes.

**CONCLUSIONS**—Including Walters' third case reported to me by letter and my three cases, there have been recorded eighty-eight total gastrectomies with forty-four operative deaths from shock, hæmorrhage and peritoneal or pulmonary infection. In the future, with improved anæsthesia and surgical technic, shock, hæmorrhage and peritoneal infections should markedly decrease in frequency. The pul-

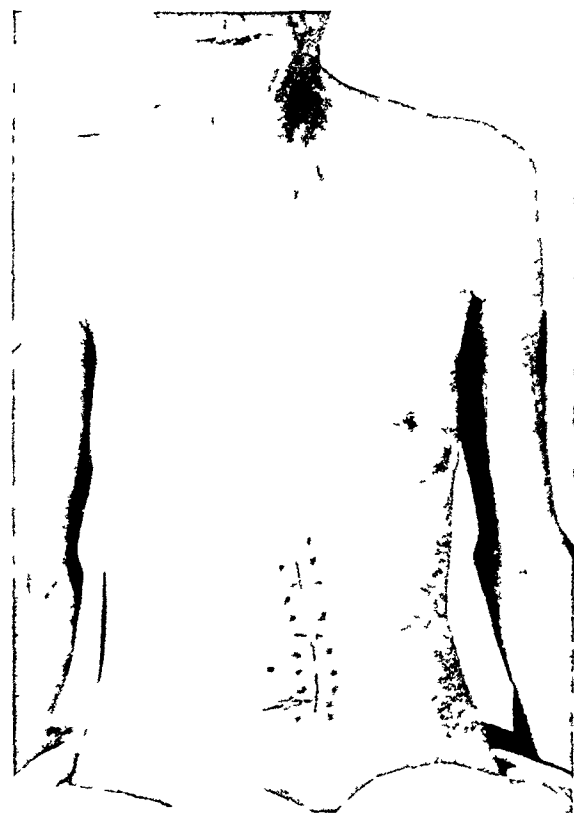


FIG 7—(Case III) Total gastrectomy. Patient four weeks after the operation. Eight weeks after removal of the entire stomach he was eating three normal size meals a day consisting of all kinds of food not predigested.

monary complications will probably be the last to diminish. Improved treatment for primary anæmia may prevent the development of primary anæmia which was so frequent following the earlier gastrectomies.

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# CARDIOSPASM ITS DIAGNOSIS AND TREATMENT \*

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THERE is probably no disease that responds more satisfactorily to proper treatment than cardiospasm. Undoubtedly, much of the confusion which exists relative to the diagnosis and treatment of the disease is due to the various terms under which it is described, such as achalasia of the œsophagus, phrenospasm, hiatal œsophagismus, megalo-œsophagus, and idiopathic, fusiform and diffuse dilatation of the œsophagus.

Properly to evaluate the efficacy of any given type of treatment of cardiospasm, it is imperative to know on what criteria the diagnosis has been based, since so many simulating conditions must be excluded to gain an accurate conception of the efficiency of the treatment applied. In this report only cases are included in which there was definite roentgenological evidence of cardiospasm, namely, persistent fusiform narrowing of the lower end of the œsophagus with obstruction and dilatation. At some point in the development of cardiospasm, the roentgenological evidence may be very scanty and indefinite, but such border-line cases have been excluded.

As Plummer has stated "The symptom complex in cardiospasm is as a rule almost pathognomonic." The course of the disease may be divided into three stages: (1) Cardiospasm without regurgitation of food, (2) cardiospasm with immediate regurgitation of food, and (3) cardiospasm with dilated œsophagus, the retention of food is in the dilated portion and it regurgitates at irregular intervals.

The onset of cardiospasm is usually insidious. Dysphagia is the prominent and the first symptom, and usually is intermittent. It first manifests itself by a sense of lagging and later actual obstruction under the lower end of the sternum. The impediment at first may be noticeable only when the patient is under emotional strain or has swallowed too rapidly. Days or weeks may intervene between attacks. With time, the difficulty increases and becomes more pronounced. Although the point of obstruction is generally situated under the lower end of the sternum, occasionally it may be referred to a point high in the throat. The dysphagia is likely to occur during the first portion of the meal. At first, the obstruction may be overcome by swallowing several times in rapid succession or by taking several swallows of water in rapid succession and washing the food on into the stomach. With increased obstruction, such simple measures may not be sufficient. The patient soon learns to swallow several glasses of water in rapid succession, take a deep breath, close the glottis and compress the thorax, thus

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\* Submitted for publication June 6, 1932

## CARDIOSPASM

increasing the intrathoracic pressure above the normal and forcing the food on into the stomach, regurgitating the remainder of the fluid. The symptoms may be intermittent over a considerable period, but they tend to progress until there is difficulty with every meal. Cardiospasm can be readily distinguished from other forms of œsophageal obstruction by the duration of symptoms and the fact that cold liquids usually give as much difficulty as solid food. Ice-cold drinks and such solid boluses of food as raw apples are probably the greatest offenders and most conducive to trouble.



FIG. 1.—Cardiospasm, demonstrating marked angulation and kinking.

Gradually, in the course of the disease, the œsophagus dilates above the point of obstruction, due partially to the effort at propulsion of the food past the point of obstruction, but more likely due to some change in the neuromuscular mechanism, since dilatation, such as occurs in cardiospasm, is not encountered in other types of œsophageal obstruction. When dilatation has occurred the first portion of the meal passes into the stomach, whereas the remainder is regurgitated or remains stagnant in the œsophagus. Of the contents that remain in the œsophagus at the completion of a meal, the more fluid portion

tends slowly to seep through the cardia and on into the stomach. The solid food with much mucus remaining in the sac is then regurgitated at frequent intervals. Solid particles of food such as meat may remain in the œsophagus for days, and food taken subsequently will pass into the stomach, the meat finally being regurgitated after several days.

Plummer was one of the first to note that the œsophagus may lengthen in cases of cardiospasm and by kinking will lead to increased dysphagia and stagnation (Fig 1). Because of the increased obstruction and retention, there is increased necessity to swallow continuously. The diet is limited to soft and liquid food taken in small amounts and washed down by large amounts of water. Considerable time must be spent over a meal. It may be necessary to empty the œsophagus during the course of a meal. This is embarrassing, and patients avoid eating in public. With restriction of diet, there is loss of weight. The obstruction may become so severe that it is impossible to get even fluids into the stomach, and if treatment is not instituted, death will result.

Pain is sometimes a prominent symptom. It varies in intensity from slight discomfort under the lower end of the sternum to severe colic in the same region or radiating to the back or up into the neck. It usually comes on during the course of the meal and when present may last until the œsophagus is empty. Vinson has pointed out that the pain may easily be misinterpreted as gall-bladder colic. Less frequent symptoms are hiccough and dyspnœa. Dyspnœa occasionally occurs as a result of a hugely dilated and filled œsophagus causing interference with respiration.

Should doubt exist as to the diagnosis after roentgenological examination, recourse should be made to the passage of a No. 45 French sound over a previously swallowed silk thread. In cardiospasm, there is an elastic feel at the cardia on passage of the sound with usually slightly more obstruction than normal, but the sound passes readily into the stomach. Œsophagoscopy does not offer as much from a diagnostic point in cardiospasm as in other diseases of the œsophagus, but should always be resorted to when there is any doubt as to diagnosis.

Various measures have been advocated in the treatment of cardiospasm, varying from palliative to operative. Palliative measures such as fluid diet, effervescent drinks, bromides and atropine, may afford temporary help. Relief at times may be secured by passage of stomach tubes and sounds, in some instances gastrostomy is resorted to. The foregoing procedures, however, are not usually effectual and something more drastic must be used. Mechanical dilators have been described and used by Lerche, Brunings, Jackson, and Mosher. Mikulicz, in 1904, first described and reported on treatment of the cardia by gastrostomy with the use of a rubber-covered forceps. Other surgical procedures such as anastomosis between the abdominal œsophagus and stomach and the longitudinal incision through the muscular wall of the abdominal œsophagus have been advocated. Although some of the procedures have afforded satisfactory results, the operation is usually attended

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by a high degree of risk, with the added disadvantage of frequent recurrence and failure completely to relieve symptoms

In The Mayo Clinic, extensive use has been made of the rubber-covered silk balloon. This type of dilator was first advocated by Russel and later modified by Plummer, who used water as the dilating medium. All dilations are carried out over a previously swallowed silk thread held taut, which eliminates all danger of perforation. Blind bougienage is mentioned to be condemned as an unwarranted and dangerous procedure. The thread is started twenty-four hours before dilatation and at least five yards should be

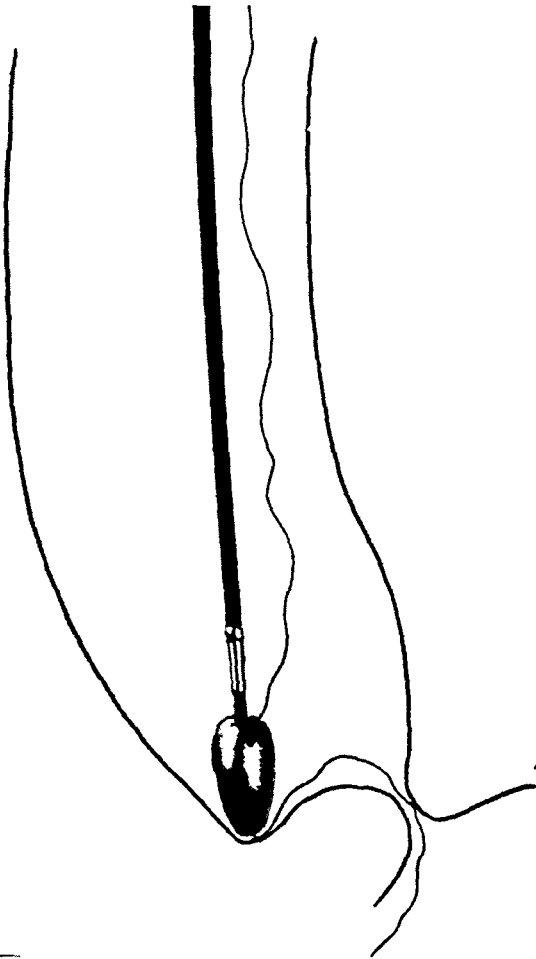


FIG 2

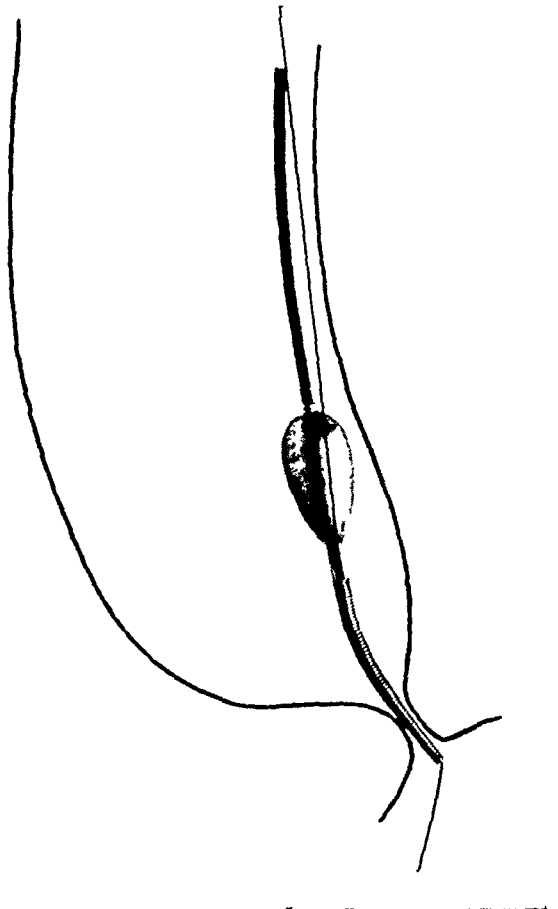


FIG 3

FIG 2—The value of the thread and the necessity of keeping thread taut, thus preventing possible perforation

FIG 3—The manner in which a No 60 French sound is passed into stomach with thread as a guide ingested. Twisted silk is preferable to braided silk, as it is swallowed with less difficulty. The thread should be taken very slowly, averaging about a foot an hour, and care should be exercised not to chew the thread to avoid snarling. The patient is permitted to partake of food during this period and to sleep at night with the thread in place. Occasionally, several days may be required to get the thread properly anchored. In rare instances in which there is marked œsophageal obstruction, with dilatation and angulation, some difficulty may be encountered. In such cases, two simple procedures are available. Several small shot may be attached to the end of the thread, then



by having the patient change position of the body, thus making use of gravity, the shot pass down to the cardia where they usually readily drop into the stomach. The course of the shot can be checked under fluoroscopical guidance. It is well to lavage the œsophagus thoroughly before starting the thread, as solid particles of food that may interfere with the passage of thread are removed. The use of atropine may also be tried in conjunction with the foregoing procedure but does not usually afford much aid. If complete obstruction of the œsophagus exists or if the foregoing procedures fail, the end of the thread with the shot attached can be dropped into the stomach.

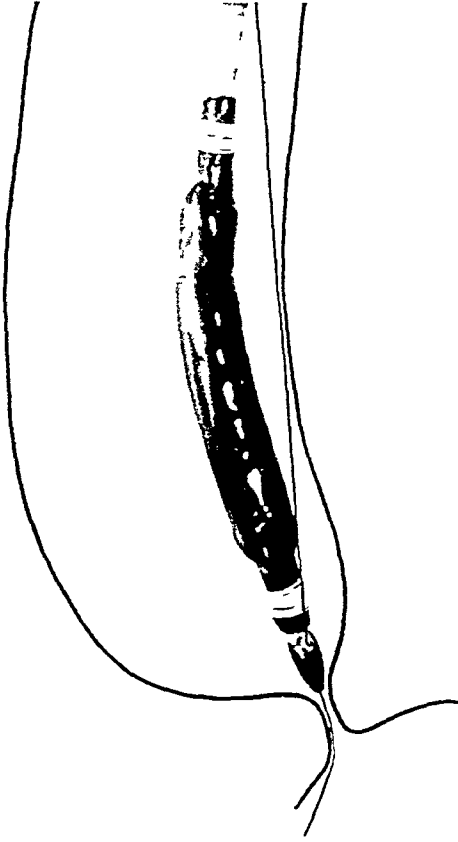


FIG 4 — Passage of Plummer hydrostatic dilator

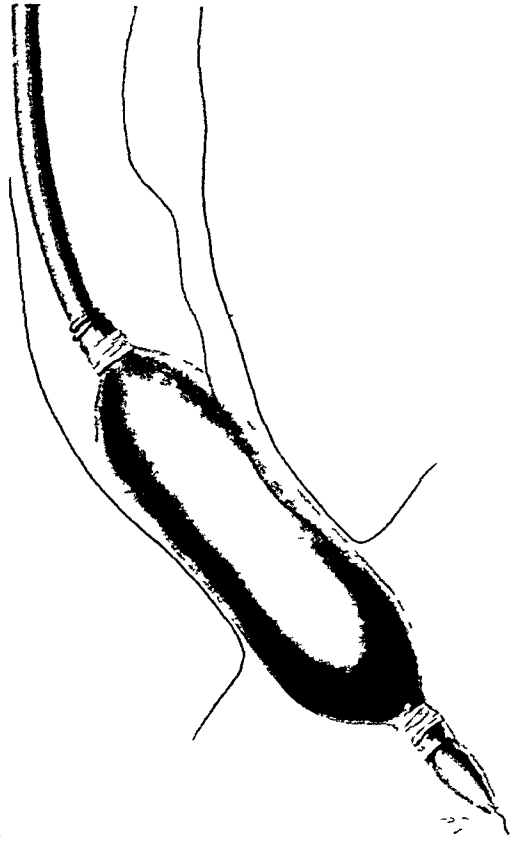


FIG 5 — Expansion of Plummer hydrostatic dilator while in cardia

by means of the œsophagoscope. I have never seen a case of cardiospasm in which it was impossible to get a thread in place. With the thread firmly anchored and used as a guide (Fig 2), a No 41 French sound is passed to determine the approximate distance of the obstruction from the incisor teeth and at the same time to determine the character of the obstruction. This simple procedure usually affords the patient some benefit, although it is rarely permanent. Formerly, this procedure was followed directly with the hydrostatic dilator, but during the last six years, a No 60 French sound has been passed first (Fig 3). In many cases, this affords complete relief of all symptoms, but as a rule further dilatation is necessary, and this is done a day or two later by means of the Plummer hydrostatic dilator (Figs 4 and 5).

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The change in technic was devised to permit of a more gradual dilatation and thereby permit of better drainage of the œsophagus, promoting epithelization of denuded and ulcerated mucosa which results from stagnation. With improved drainage, the ulcerated areas melt rapidly, with marked improvement in the tonus of the œsophagus. Previous to using the No. 60 French sound, as a preparatory stage to the use of the hydrostatic dilator, death resulted in approximately 1 per cent of the cases following primary dilatation with the hydrostatic dilator, due to splitting of the œsophagus. Since 1926, the use of the No. 60 French sound has been carried out as a routine at The Mayo Clinic, preceding the hydrostatic dilatation, and since then there has not been a fatality in the treatment of approximately 400 consecutive cases.

Up to January, 1932, 810 cases of definite cardiospasm have been observed at The Mayo Clinic. Many other cases in which treatment for cardiospasm was given have not been included because of lack of clear-cut roentgenological evidence of the presence of cardiospasm. Treatment was given in 805 of the 810 cases. The results obtained by dilatation, either by sounds or by hydrostatic dilator, are as follows:

Eight hundred four dilatations were given, 670 patients were traced, 475 were considered cured, including those with slight intermittent dysphagia, 105 patients were moderately relieved, thirty-two were slightly relieved, thirty-two received no benefit, three refused treatment, nine died from splitting of the œsophagus (no deaths since 1926), two died from starvation before treatment could be instituted, and twelve died at home from other causes, the condition of dysphagia at that time was unknown. In three cases, owing to marked angulation of the œsophagus, it was not possible to place the hydrostatic dilator to secure dilatation and operation was performed. In each case, a Mikulicz operation, or manual dilatation of the cardia, was carried out through a gastrostomy.

In 71 per cent of the cases in which dilatation was done the condition may be regarded as completely relieved. It is frequently stated by opponents to this type of treatment that the necessity for repeated dilatations is an objectionable feature. The inaccuracy of such a statement is well illustrated in a summary of the number of dilatations necessary in the treatment of 125 consecutive cases of cardiospasm in which the average number of dilatations was less than two. The largest number of dilatations in any case was ten, in the majority of cases only one dilatation was required. It is a rather interesting fact that the results are as good if not better in cases of long standing as in those of short duration. The average duration of symptoms in the cases in the clinic has been about seven years. As I have pointed out, the disease may be present in infancy and childhood, and the treatment in such cases is the same as for adults.

No doubt a certain percentage of many of the patients listed as only moderately improved, or unimproved, could be further relieved by subsequent

dilatation Further treatment usually has not been tried as the patients feel that they are able to get along fairly well in their present condition

There are various reasons for failure to obtain satisfactory results from hydrostatic dilatation, the most common of which is failure to use a thread as a guide This thread is absolutely essential in order to have the dilator directly in the cardia at the time of dilatation Should the dilator slip too far into the stomach on expansion, it will pull itself into the stomach, if it is not far enough in the cardia, it will push up into the œsophagus on expansion, thereby failing to dilate the cardia thoroughly When difficulty is encountered in locating the cardia, the dilator can be placed in the stomach, expanded, and then pulled firmly against the cardia The pressure is released and the dilator is pulled into the cardia and rapidly reexpanded Fluoroscopic guidance is also available, but adds to the confusion and difficulty of manipulation With the dilator properly in place, substernal pain is practically always present on dilatation

The dilating bag must be of proper size and shape to obtain satisfactory results The degree of water pressure is also of importance, in the majority of cases a pressure of eighteen to twenty-four feet of water will be sufficient and this should be varied with the degree of dilatation present and the degree of discomfort produced

In conclusion, it may be stated that cardiospasm is amenable to treatment by means of the Plummer hydrostatic dilator and when preceded by passage of a No 60 French sound, should be carried out without risk

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## EXTERNAL DUODENAL FISTULA

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ACUTE external duodenal fistula is a serious and formidable complication of disease of, or injury to, this portion of the alimentary tract Colp,<sup>1</sup> who reviewed the literature to 1923, collected sixty-one cases with a mortality of 51 per cent Since that time several significant contributions have been made concerned chiefly with studies of the cause of the profound bodily disturbances which usually accompany this lesion, as well as adequate measures for combating these changes Valuable suggestions have also been made regarding the treatment of the wound itself so that Bohrer and Milici<sup>2</sup> were able recently to collect forty-four additional cases (since 1923) with a mortality of 18 per cent

It is unnecessary to review again the causes, pathological physiology, and symptoms of duodenal fistula, as these have been adequately dealt with in recent contributions Suffice it to say that the chief contributing factor is surgical attack on the duodenum or some neighboring structure (stomach, gall-bladder, biliary ducts, and right kidney)

The profound constitutional disturbances resulting from this lesion had intrigued all those who had occasion to see these cases The mere loss of liquids through the fistulous opening was not sufficient to account for the marked and rapid inanition and exhaustion It remained for Walters<sup>3</sup> and his associates to demonstrate that the physico-chemical changes that occurred consisted of increasing alkalosis, decreasing concentration of chlorides in the blood serum, and progressive rise in the blood urea These findings were identical with those found in cases of high intestinal obstruction Walters<sup>4</sup> subsequently showed experimentally that the chemical reactions in the blood were chiefly the result of the loss from the body of the acid and chlorides of the gastric secretion, the loss of the pancreatic fluids, and disturbances in motility in the upper intestinal tract Elman and McCaughan<sup>5</sup> had previously pointed out the fatal effect of the complete loss of pancreatic juice, and Dragstedt and Ellis<sup>6</sup> have recently demonstrated the lethal effect of the total loss of gastric juice This experimental work has led to more rational and scientific methods in combating the symptoms described above

While it is doubtless true that many small fistulæ close under simple conservative management, the larger openings demand prompt and energetic measures to prevent the rapid decline of the patient Liquids are withheld by mouth and given intravenously, subcutaneously, and per rectum (saline, glucose, water) Numerous operative procedures which have been advocated at various times have been discouraging—direct suture of the duodenum, gastroenterostomy, and gastroenterostomy with pyloric occlusion

(Berg) Jejunostomy, however, has received more and more favorable comment, and this procedure alone has frequently sufficed to bring about a successful issue

The treatment of the wound has taxed the ingenuity of surgeons for many years. The fact that so many different methods have been suggested and employed is sufficient reason to believe that we have not yet reached the ideal treatment. Whatever else is done, suction must be employed to keep the wound free of secretions. This was first used by Jones and Williams,<sup>7</sup> who did not, however, record their experiences. Erdman,<sup>8</sup> Cameron,<sup>9</sup> and others since then have emphasized this important measure. The skin should be protected by some simple ointment. Potter<sup>10</sup> suggested, several years ago, the use of decinormal hydrochloric acid with a sterile beef and olive oil preparation, the rationale being that the acid neutralized the secretions and the beef extract and olive oil allowed the pancreatic juices to act on it before the secretions acted on the abdominal wall. In a subsequent report Potter<sup>11</sup> added nine cases successfully treated by this method. Others have irrigated the wound with sodium bicarbonate solution,<sup>12</sup> citric acid,<sup>13</sup> and sterile water.<sup>7</sup> Insulin<sup>14</sup> has been used on the continent. Einhorn<sup>15</sup> recommended the use of the duodenal tube.

The attempt to close the fistulous opening by passage of a tube directly through the opening into the duodenum has received little attention. Ahrens<sup>16</sup> reported a case of post-operative duodenal fistula successfully treated by passage of a T-tube into the fistulous opening. A second case treated in similar fashion was reported by Marogna,<sup>17</sup> who passed a long rubber tube into the jejunum through the fistula. The author, however, subsequently resorted to extraperitoneal suture of the opening (the lesion had followed nephrectomy). We were able, in our patient, to pass a small catheter through the fistulous opening into the duodenum. Two things were accomplished by this manoeuvre—the amount of secretion was greatly diminished, and the patient was easily fed through the tube. The opening promptly closed.

The fact that this simple and logical procedure has received so little attention prompted us to make a brief report of the following case.

CASE.—Mrs. E. S., forty-two years old, who had had dyspeptic symptoms of the gall-bladder type for many years, was admitted to the hospital with a diagnosis of empyæma of the gall-bladder. The abdomen was opened through a short right rectus incision, and a large abscess cavity was immediately encountered, apparently in the region of the gall-bladder. No further exploration was done. The pus was aspirated and the abdomen closed with two cigarette drains. She was discharged in good condition and returned five months later for cholecystectomy. The gall-bladder was removed after much tedious and difficult dissection because of numerous dense adhesions. In the course of the dissection the duodenum was inadvertently injured, but immediately repaired. The abdomen was closed with gauze drainage. On the fifth post-operative day a profuse foul-smelling discharge was noted in the wound. Methylene blue by mouth reappeared quickly in the discharge and confirmed the suspicion of duodenal fistula. Drainage thereafter became more profuse. The wound was kept as dry as possible by suction, the skin was protected by a thick Kaolin paste, and large quantities of liquids were administered. There was no alteration in the chemistry of the blood. The patient, however, was weak and apathetic,

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and despite much care the wound appeared raw and excoriated After several attempts we finally succeeded in passing a small catheter through the fistulous opening into the duodenum Feedings were begun at once through the tube and the secretions collected by suction were also re-introduced through the catheter Within a few days the patient became brighter and more alert, drainage began to diminish, and the wound began to lose its angry appearance Improvement thereafter was fairly rapid The tube was removed two weeks after its insertion and the patient was discharged on the thirty-ninth post-operative day with the fistula closed and the wound entirely healed She was re-examined one year later and save for a small incisional hernia was in excellent condition

*Summary*—A case of post-operative (cholecystectomy) duodenal fistula is reported successfully treated by passage in a tube through the fistulous opening into the duodenum With tube in place the amount of secretion in the wound is diminished and through it a patient may be adequately fed Where feasible this procedure is suggested because of its simplicity

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# THE EXCORIATIONS AROUND EXTERNAL GASTRO- INTESTINAL FISTULÆ

EXPERIMENTAL STUDIES ON THEIR ETIOLOGY AND FURTHER EXPERIENCE  
WITH THE KAOLIN POWDER TREATMENT

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WHILE the excoriations of the abdominal wall in the region around a duodenal fistula or an ileostomy opening have long been suspected of being due to tryptic digestion, no conclusive experimental proof of this, has been forthcoming. In the first place, the ability of an enzyme to digest the living skin has not been definitely demonstrated, and in the second place, there is the possibility of the excoriations being due to a bacterial process. The fact, however, that the excoriations are erosive rather than sloughing in character would suggest a non-bacterial and non-inflammatory process. Moreover, there are other instances of enzymes attacking living tissues, such as fat necrosis in some types of pancreatic disease.

Blad<sup>1</sup> has shown that pancreatic juice injected into the gall-bladder which is prevented from emptying by ligation of the common duct causes changes in the gall-bladder wall, which terminates in necrosis. This observation was recently confirmed by Westphal and Wolfer,<sup>2</sup> the former ruling out the bacterial factor by passing the pancreatic juice through a Berkefeld filter before injecting it into the gall-bladder.

Babkin,<sup>4</sup> in Pavlov's laboratory, made a significant observation on dogs with pancreatic fistula. In the operation to establish the fistula, a small piece of the duodenal wall is excised, having the papilla of the pancreatic duct opening in the middle of its mucous surface. The excised piece is then brought to the surface and stitched to the abdominal wall. In dogs in which the excised piece of mucosa is left in place on the abdominal wall, the latter is liable to suffer severe excoriations, while in those in which it is excised, excoriations do not occur. This observation is explained thus: the unactivated trypsin, formerly called trypsinogen, from the pancreas needs activation by the enterokinase from the duodenal mucosa before it can cause excoriations (digestion).

*Skin Digestion Experiments*—In our laboratory in five series of experiments on the dog we have been able to show the tryptic nature of excoriations. Briefly they are:

*Series I*—(Five experiments) A closed loop was made of the duodenum into which the accessory pancreatic duct empties. By the injection intravenously of secretin, an abundance of fluid was collected in the loop. This fluid was made to flow into the inguinal fossa of another dog and kept there at a temperature of 38° C. Visible skin excoriations occurred in eight to ten hours.

*Series II*—(Three experiments) The accessory pancreatic duct\* was

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\* In the dog the accessory pancreatic duct is larger than that which corresponds to the main pancreatic duct in man.

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cannulated and the pancreatic juice, stimulated to flow by secretin, was led in a similar fashion into the inguinal fossa of another dog. No visible excoriations occurred in fifteen to eighteen hours.

*Series III*—(Three experiments) The pancreatic ducts were ligated, and the duodenal juice was applied to the inguinal fossa of a second dog.



FIG. 1.—The inguinal fossa of a dog showing beginning excoriations caused by the application of ultra-filtered duodenal juice.

under identical conditions as the above. No excoriations were present in fifteen to eighteen hours.

*Series IV*—(Three experiments) The pancreatico-duodenal juice was collected from a dog aided by the injection of secretin. This juice was ultra-filtered through a Zsigmondy membrane filter to render it bacteria-free (checked by sterility tests) and applied to the inguinal fossa of a second



dog under the same experimental conditions. Excoriations occurred in five to eight hours. (See Fig 1)

*Series V*—(Five experiments) A 1 per cent aqueous solution of pancreatin (Merk) was raised to pH 7.0 by the addition of a 1 per cent sodium carbonate solution and applied to the inguinal fossa of a dog. The mixture was kept at a temperature of 38° C throughout the course of the experiment. Excoriations were visible in ten to twelve hours. By raising the pH to 8.2, they occurred in five to eight hours. Controls of sodium carbonate solutions at pH 7 and pH 8.2, or of the boiled mixture raised to the same hydron concentration, showed no excoriations at the end of fifteen to eighteen hours.

The first three series of experiments show that the excoriative process depends upon the activation of unactivated trypsin by enterokinase—that is, the process is due to tryptic digestion.

The fourth series shows that the excoriations are not bacterial in origin.

The fifth series shows that the excoriations are reproducible by commercial pancreatic enzymes and that the production of these excoriations is hastened by raising the pH to nearer the optimum for trypsin action.

*Colonic Fistula*—Strangely enough, excoriations around cecostomy openings, fecal fistulae or other types of artificial anus have not so generally been recognized as being caused by digestion, probably due to the erroneous belief that trypsin becomes inactive or disappears on passing through the ileocecal valve and that it ceases to act in an acid medium.

As a matter of fact, trypsin can almost always be demonstrated in the fecal discharge from a cecostomy and often in that from a sigmoidostomy. The table below represents a study made on the tryptic contents of stools collected from eight cecostomy and five sigmoidostomy cases. The Fuld-Gross<sup>5, 6</sup> method of trypsin determination as described by Porter<sup>7</sup> was used. Briefly, the method consists in making fecal solutions (filtrates) of 1/10, 1/100 and 1/1000, the introduction of each dilution in two cubic centimetres, one cubic centimetre and 5 cubic centimetre quantities into test-tubes, the addition of five cubic centimetres of a 1 per cent alkaline solution of casein to each tube, the addition of a few drops of toluol to each tube to inhibit bacterial activity and the incubation of the tubes at 38° C for twenty-four hours. At the end of this time, six drops of 1 per cent acetic acid are added to each tube. In the tubes in which digestion is complete the liquid remains clear, while in those in which some casein still remains it is precipitated. A unit is taken to represent that amount of trypsin present in one cubic centimetre of the extract that completely digests one cubic centimetre of the casein solution. Thus if one cubic centimetre of 1/1000 digests five cubic centimetres casein solution, then one cubic centimetre of undiluted extract would digest 5,000 cubic centimetres of the solution and the unitage is therefore 5,000.

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TABLE

*Trypsin Contents of Fistular Fecal Discharge*

Name	Type of Fistula	Character of Discharge	Units Trypsin
G B	Cecostomy	Semi-fluid	1000
W F	Cecostomy	Soft solid	500
E M	Cecostomy	Fluid	1000
G C	Cecostomy	Fluid	2000
F H	Cecostomy	Semi-fluid	1000
B I	Cecostomy	Semi-fluid	500
	Cecostomy	Fluid	2000
G W	Cecostomy	Soft solid	250
F W	Sigmoidostomy	Soft solid	250
D C	Fecal fistula sigmoid	Fluid	2000
M C	Fecal fistula sigmoid	Semi-fluid	500
F J	Sigmoidostomy	Soft solid	250
P P	Sigmoidostomy	Soft solid	200

The above table shows that trypsin can often be found in the fæces in relatively high unitage. The statement that trypsin ceases to act in an acid medium is only relatively true. While the optimum reaction of trypsin is between pH 8 and pH 9, it is not inactive until the acidity approaches pH 5.<sup>8</sup> If trypsin were to lose its activity at a slightly acid reaction, then it would fail to act altogether in the small intestine, where, according to McClendon, Myers, Culligan and Gydesen<sup>9</sup> the pH ranges between 5.6 and 6.6. In fact, the stool increases in alkalinity in the large intestine<sup>10</sup> and Howe and Hawk<sup>11</sup> found the reaction of the fæces to be uniformly alkaline, while Robinson<sup>10</sup> found it to be between pH 7 and 7.5.

There are also experimental and therapeutic evidence to believe that even the excoriations in the buttocks of infants with diarrhoea, the condition that has been called diaper disease, ammoniacal dermatitis, Jacquet's disease, *etc.*, by the pædiatrician, may be due to the same digestive process. The infrequency of excoriations around cecostomy and sigmoidostomy openings thus seems not to be due to the absence of trypsin in the stools, but rather to the more solid state of the stool, so that trypsin does not come into intimate contact with the tissues.

*Review of Therapeutic Measures*—The control of the excoriations is frequently a vexatious problem. Atropine and sodium fluoride have been used internally without much success in the hope of drying up the discharge. The first advance was made by Jones and Williams,<sup>12</sup> followed by Erdman<sup>13</sup> and Lahey,<sup>14</sup> all of whom employed mechanical aspiration of the fluid discharge from duodenal fistulæ. While this mechanical removal serves an excellent purpose, yet its usefulness is limited where the bowel contents have solidified to any extent.

In 1926, Smith and Christensen<sup>15</sup> reported a series of three cases of peristomal excoriations cured by the use of Kaolin paste made with glycerine. For some reason or other this report passed unnoticed, so that when Potter,<sup>16</sup>

in 1929, reported the less efficient and much clumsier beef-juice-hydrochloric-acid treatment, it was adopted widely by surgeons

Early in 1926, before the appearance of the work of Smith and Christensen, while searching for a means of controlling the extensive excoriations surrounding a sigmoidostomy opening, we were led to the work of Petersen,<sup>17</sup> in 1917, who demonstrated the inhibiting effect of Kaolin powder on the digestive power of jejunal juice. The use of the powder in our cases was followed by such prompt healing that it was instituted as a routine procedure in treating all types of gastro-intestinal fistulæ. A series of thirty-one cases was collected over a period of three years and published by us in 1930.<sup>18</sup>

Since then we have had 162 cases collected from the surgical and gynecological wards of the New York University Division of Bellevue Hospital, New York, from the Michael Reese Hospital, Chicago, and the Harlem Hospital, New York.\* Rankin and Graham,<sup>19</sup> who started using this treatment at The Mayo Clinic in the summer of 1931, reported highly satisfactory results in three cases of high intestinal fistulæ and eleven cases of permanent ileostomies. Sir Arthur Buigess<sup>20</sup> also speaks of the treatment as having revolutionized the post-operative treatment of fistula cases in his practice. In our hands, the treatment has been so successful as to instill in us the confidence that one has in specifics, and we are almost justified in making the statement that with the proper use of Kaolin powder in the routine toilet of an external gastro-intestinal fistula, no excoriations need occur.

*Principle and Method of the Kaolin Powder Treatment*—The principle of the treatment is the removal of the enzyme, trypsin, by kaolin particles because of a difference in their electrical charge. This treatment is carried out in the following fashion. A plentiful amount of kaolin powder is applied over the ostium of the fistula and all around it. The number of changes necessary depends upon the condition of the abdominal wall and the amount of drainage. A safe rule is to change the powder as soon as it becomes saturated. In duodenal fistulæ, it is generally necessary to change the powder every hour or every two to three hours, in ileostomies, every four to six hours, in cecostomies, every four to eight hours, and in sigmoidostomies twice a day. It must be borne in mind that the success of the treatment depends upon the removal of as much of the enzyme as the fistula discharges. The application of vaseline to the abdominal wall before using the powder defeats the purpose for which Kaolin is used, as the vaseline-coated particles of Kaolin then become electrically inert.

*Advantages of the Kaolin Powder Treatment*—At the time of the publication of Smith and Christensen's work,<sup>15</sup> we had collected seven cases, all treated satisfactorily with the Kaolin powder. It seemed desirable, however, to give Smith and Christensen's method and ours a test of comparative

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\* We are grateful to Drs. Francis Sovak and Henry Falk for the use of the clinical material from the gynecological ward of the Bellevue Hospital and from the Harlem Hospital, respectively.

efficacy After a few trials, it was apparent that the powder method was the more effective This is to be expected Efficient removal of the enzyme by Kaolin depends upon its intimate mixture with the fistular discharge In the case of the powder, an intimate contact is insured by capillarity due to porosity of the powder, whereas in the paste, the pores being already filled with glycerine, contact must depend upon the diffusion of the discharge into the glycerine matrix—a much slower process

The Kaolin treatment has a number of minor and major advantages over the beef-juice-hydrochloric-acid treatment, the minor advantages are that it is less clumsy, comes ready for use, is inexpensive, and that it adsorbs bacteria The major advantages are

(1) Because of its simplicity, it can be used for any type of bowel fistula, including ambulatory cases

(2) There is neither the inconvenience, the discomfort to the patient nor the foul odor that attend the hydrochloric-acid-beef-juice treatment

(3) It can be used for a prolonged period of time without producing irritation of the skin (in one case as long as six months)

(4) It is valuable in preventing digestion around any fistular opening

#### SUMMARY

(1) In five series of experiments on the dog, it was established that trypsin can cause skin excoriations

(2) One hundred and sixty-two cases of perististular excoriations treated with the Kaolin powder method are reported The results were so uniformly good as to justify classifying the treatment as a specific

(3) The principles, the technic, and the advantages of the Kaolin powder treatment over other existing methods are set forth

The author wishes to acknowledge his thanks to

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(2) Mrs Ruth Kidd of the Department of Bacteriology for carrying out the sterility tests on our ultra-filtered material

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# ARTERIAL EMBOLLECTOMY

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THIS paper includes a report of arterial embolectomies performed by the writer and a review of the literature from the time that the subject was first brought prominently to the attention of the medical profession by the Scandinavian surgeons, particularly by Einar Key,<sup>35</sup> ten years ago

The total number of cases collected from the literature of the Scandinavian, German and other European countries, and that of Australian, Canadian and American medical publications, from 1922 to June, 1932, totals 129. These 129 cases were reported by eighty different surgeons. In collecting our material for this paper, we were very careful not to include any of the cases reported by Key in his first paper of 1922. These 129 cases were operated on by a diversified group of surgeons, whose experience with this particular branch of surgery was rather limited. Most surgeons only reported one individual case, some two or three, the highest number reported by any single surgeon in this group being limited to seven cases.

In Key's first collected group of cases published in 1922, beginning with the first successful case of embolectomy performed in 1911, are included reports of operations performed almost exclusively by Scandinavian surgeons. The only case by an American surgeon included in his bibliography is that of Francis Stewart, who removed an embolus at the bifurcation of the aorta several days after its onset with fatal results. Previous to 1911, several attempts to relieve embolic arterial obstruction were made by many surgeons without any success. In Europe, Ssabanejew (1895), Lejar (1902), Moynihan (1903), Handley and Doberauer (1907) performed arteriotomies on various arteries without any success. Trendelenburg (1907) removed an embolus from the pulmonary artery of a woman, sixty-two years old. Death from hæmorrhage took place on the operating table. Since that time, after much experimental work, this operation was perfected by him with some successful results. Proust and Lecène (1908), Schiassi (1909), Carrel and Leriche in the same year attempted to remove emboli from the femoral, brachial and iliac arteries, gangrene requiring amputation developed in every case. Leriche and Murad (1911) removed a clot from the external iliac artery several days after the onset of the disease. The patient died on the operating table.

In America we find that attempts to relieve this condition by surgery were made by Francis Stewart in 1905 and 1907. Each time he removed an embolus from the femoral artery, and gangrene developed in each case. In 1909, Murphy removed an embolus from the iliac artery, twenty-four hours after onset. Gangrene was already present at the time of operation and the patient died four days later.

Since Labey published his first successful case in 1911, the number of operations performed upon the vessels of the extremities progressively increased, particularly in the Scandinavian countries. From that time on we find that three arteriotomies were performed in 1912, one of which was for an embolus lodged at the aortic bifurcation, followed by recovery. The same number of operations were performed in 1913 with one good result. In 1914, five operations were performed by five different surgeons, with one successful result. Eight operations were performed during the years of 1915 and 1918, with two successful results. In 1919 Key reported before the Nordischen Chirurgischen Gesellschaft nine embolectomies performed on eight patients, and Wideroe in the same year reported five cases. From that year up to 1922 there were isolated instances of this operation performed mostly by Scandinavian surgeons, the results of which were published in Key's paper in 1922.<sup>32</sup>

Of the total number of 129 cases included in our review of the literature covering a period of ten years (1922-1932) 119 were subjected to operation and the diagnosis was confirmed at operation. (Four of these were performed by the writer.) In the remaining ten non-operated cases, the diagnosis was established by the classical clinical symptoms present at the time of onset of the disease, by post-mortem findings, or both. Operation in these cases was not performed for various reasons. We included these non-operated cases in our series for the purpose of comparative study of the end-results of those cases which were operated on, as compared with those in which no operation was done.

The constant progressive increase in the number of operations performed for the relief of this condition may be judged from the number of cases included in this group: twenty-three American surgeons reporting fifty operations during this period, and twenty-one Scandinavian surgeons reporting thirty-eight cases. The remaining number of cases are divided between the British, German, French and South American countries.

We presume that there may be an equal or even greater number of cases which were operated on and not reported in the literature since we are more prone to report our successes than our failures. Some of the successful cases reported in the literature may have escaped our notice, particularly those published in the foreign medical magazines (E. Andrews, M.D., and Henry Harkins,<sup>3</sup> M.D., state that 216 cases of embolectomies were collected until 1927, of which 145 were done in the Scandinavian countries.) Our group of 129 cases constitute a series sufficiently large to draw some fairly definite conclusions, particularly so since the operative results are not confined to a limited group of surgeons or to any particular country.

*Etiology*—The predominating factors in the causation of arterial emboli are affections of the heart and blood-vessels, either in the acute, subacute or chronic stage. It may occur in any of the stages of this disease but it is apt to occur more frequently in acute exacerbation of a chronic endocarditis, particularly when associated with diseases of the blood-vessels. (Sixty per

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cent of our cases are purely of cardiac origin ) It seldom occurs as a post-operative complication in patients in whom there is no history of a previously existing constitutional disease In 82, or about 70 per cent of our operated cases, the etiology was of a cardiac nature Twenty-two out of these eighty-two patients also suffered from other complicating diseases, such as arteriosclerosis, diabetes, syphilis, thyrotoxicosis, *etc* (Table I ) In eighteen cases the embolus followed a surgical operation In six of these there was a history of cardiac disease existing prior to operation and in the remaining twelve we find that three were operated on for toxic goitre, which is usually associated with cardiovascular changes The remaining nine cases, whose average age was forty-nine years, might have had some latent heart lesions, not detected at time of operation From these clinical findings, we may definitely establish the following corollary that "arterial emboli are almost invariably the result of diseases of the heart and blood-vessels "

TABLE I

*Etiology*

Alcoholic (?)	2
Arteriosclerosis	6
Arteriosclerosis and diabetes	1
Bullet wound in lung	1
Cardiac	60
Cardiac and post-operative	6
Cardiac and pregnancy	1
Cardiac and syphilis	1
Cardiovascular	9
Compound fracture	1
Diabetes	1
Diabetes and cardiovascular	2
Eclampsia gravidarum	1
Etiology not given	10
Graves' disease and typhoid	1
Malaria (?)	1
Pneumonia (?)	1
Pneumonia and serum sickness	1
Post-operative	12
Puerperal sepsis	1
Septic endocarditis	3
Streptococcus infection	1
Syphilis and aneurism of aorta	1
Syphilis and arteriosclerosis	1
Thrombosis of right iliac vein	1
Thyrotoxicosis	1
Tuberculosis	1
Tuberculosis and pneumonia	1
Total	129

Emboli may originate from a central spot in the artery, usually from the aorta, as was demonstrated in one of our cases by the post-mortem findings They usually come from the left side of the heart, mitral disease being the



most common cause of cardiac thrombus formation<sup>32</sup> About 50 per cent of Key's first collected cases suffered from this form of cardiac affection Occasionally they may originate in the right side of the heart or in the systemic veins In the last two possibilities we must presume the presence of a patent foramen ovale, permitting the embolus to pass directly from the right to the left side of the heart, and thence to the general arterial circulation These are usually spoken of as "paradoxical" or "cross" embolus

Arterial or venous thrombi, which are occasionally the cause of embolism, are usually the result—according to experimental studies carried on by Aschoff<sup>17</sup>—of changes in the composition of the blood or retarded blood circulation, such as is found in advanced cases of cardiac decompensation, or the result of injuries to the vascular coats, facilitating local thrombus formation

The importance of early operation is stressed by most writers who, either through a personal experience with several cases, or by a resume of a collected series of embolectomies, were able to compare the end-results of the cases diagnosed and operated on early, with those cases in which the operation was delayed It was definitely shown<sup>43</sup> that the longer the period of occlusion, the more extensive is the infiltration of the intima of the blood-vessel causing grave alteration in the vascular lining The embolus adheres very closely to the vessel wall, causing ulceration and ultimate necrosis at the intima and media, at the obstructed point This process gradually extends to the vessel walls below the point of embolic lodgment Very little may be expected from a late operation, since the vascular changes are so far advanced that thrombus re-formation usually takes place after the embolus is removed, causing complete obliteration of the entire arterial canal

The danger of circulatory obstruction by an embolus is greater than that caused by ligation, because, in the former, thrombi rapidly form and occlude not only the parent vessel but also the arterial branches given off at the embolic site, whereas in obstruction due to ligation the branches given off below the point of ligation are not obliterated and the circulation may be maintained through these collateral anastomotic branches Then again we must bear in mind that emboli usually form in debilitated subjects in whom the collateral circulation is definitely impaired

That ligation of arteries carries with it less risk of gangrene than when the obstruction is due to an embolus, and that there is an appreciably smaller percentage of gangrene following ligation of the arteries of the upper extremities than that of the lower, was definitely shown by Wolf (Quoted by Key<sup>32</sup>) Experimental ligation of the common iliac, femoral and popliteal gave a percentage of gangrene, varying from 50 per cent in the common iliac down to 15 per cent in the popliteal In ligation of the subclavian, axillary and brachial arteries, the percentage of gangrene varied from 15 per cent in the axillary to 4.8 per cent in the brachial As will be shown later, the same variation in the incidence of gangrene between the vessels of the upper and lower extremities, as a result of embolic obstruction, also holds true

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While there may be other factors influencing the operative outcome, such as the condition of the patient, the condition of his heart and blood-vessels, the location of the embolus with reference to the accessibility of the vessel and the existence of other concomitant affections, nevertheless the best chances for an operative cure depend upon the promptness of operative intervention. The family physician is usually the one who sees the patient soon after the occurrence of this surgical complication, and unless he is familiar with the modern surgical literature on the subject, or has had some previous personal experience with it, the condition may go unrecognized for several hours or even days and when the real cause of the trouble is recognized, gangrene has already set in, or the resulting thrombus in the vessel wall has become so firmly adherent, causing such marked changes in the intima of the blood-vessel, that operation is almost futile. At best the ultimate end-results of the cases followed up after their recoveries, even in those instances where the operation was performed within the first twelve or twenty-four hours after the onset of the disease, are far from what would be desired, and unless the general practitioner or even the general surgeon learns to diagnose and promptly render the necessary surgical relief, the operative results will remain far from satisfactory.

*Symptoms and Diagnosis*—It is important to differentiate between an arterial embolus and an arterial thrombus which is due to disease of the blood-vessel wall. The history of an organic heart lesion, with recent exacerbation, the presence of some form of systemic infection, a post-operative condition associated with cardiovascular disease, and a sudden onset of pain along the course of one of the vessels of the extremities, should lead one to suspect the presence of an arterial embolus.

In arterial thrombus there is usually a history of prodromal symptoms extending over a period of months or years, such as coldness and numbness of the extremities, intermittent claudication, and all other symptoms of circulatory disturbance that are usually present for a long time before definite symptoms of complete arterial obstruction appear.

The subjective signs of arterial obstruction by an embolus are sudden onset of pain in the affected limb, which is rather sharp and persistent. This is followed by a sense of coldness, numbness and tingling sensation with a progressive loss of motion being completely abolished in some cases where the obstruction is complete.

The objective signs are a rapidly changing color of the skin in the affected limb. The skin becomes pale, assuming a marble-like appearance, the temperature of the limb is lowered, motion is markedly restricted and, at times, completely abolished. As the intensity of the obstruction becomes more marked, cyanosis of the skin develops, the discoloration becomes very marked, livid dark blue patches appear, followed by complete gangrene of parts below the obstructed point.

One of the most outstanding and dependable symptoms for early diagnosis is the absence of pulsation in the affected vessel below the point where

the embolus is lodged. This can be easily established—particularly in thin individuals—in those vessels that are somewhat superficial along certain parts of their course such as the axillary or brachial, the first portion of the femoral or popliteal.

In one of my own cases I was able to locate the embolus definitely in the brachial artery, at about the upper third of the forearm before the incision was made. Palpation along the course of that vessel demonstrated a small segment of the artery of a cord-like consistency. There was distinct pulsation above that point and none below it. A tiny little mass, the size of a pea, could be felt within the vessel just above the cord-like segment and could be easily displaced upward into the vessel lumen by gentle massage. We encountered a similar condition in an embolus of the axillary artery.

The location of the embolus is not so easy in those vessels or parts of certain vessels which are covered by muscle and adipose tissue such as the middle portion of the femoral below Hunter's canal, the posterior tibial, internal iliac and subclavian. It should be borne in mind that when a rich collateral circulation is present the circulatory disturbance may be manifested at a point quite distant peripherally from the point of embolic obstruction.

The most important differential diagnostic point between venous thrombosis and arterial embolism is the fact that in the former the pulse is palpable along the entire course of the limb and the extremity is cyanotic and warm, whereas in arterial obstruction by embolus there is no pulsation below the obstructing point, the color of the skin is at first pale, marble-like in appearance, and the limb is cold.

*Pain*—The cause of the sudden onset of pain is usually given as due to the marked ischæmia immediately following the arterial occlusion. Some writers maintain that the pain appears only after the formation of a thrombus of sufficient size to cause complete obliteration of the arterial channel and that it is not due nor does it follow immediately after the lodgment of the embolus. If that were so, we should get a history of a slowly progressing pain instead of a sudden onset.

The pain, in my experience, is always sudden, without any premonitory symptoms and continues with the same severity as long as the embolus remains lodged in the vessel. Considerable relief from pain is obtained as soon as the embolus is extracted, even in those cases where the circulatory restoration is not complete. It is my belief that the onset of pain is due to the sudden arrest of the embolus along its course in the arterial blood-stream, at or near a bifurcation point, or at a constricted portion of the vessel. This is followed by a spastic contraction of the vessel and the branches given off at or near that point as a result of the vessel's effort to propel the embolus along the arterial course.

*Anæsthesia*—Arteriotomies for arterial emboli should be performed under local anæsthesia whenever the vessel involved is easily accessible and extensive dissection is not necessary. The third portion of the axillary artery, the

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brachial or superficial portion of common femoral, are particularly adapted for this form of anæsthesia

In the deep-seated vessels of the lower extremity and the intra-abdominal arteries, spinal anæsthesia should be administered. It is particularly indicated in this condition since most of the patients afflicted with this surgical disease are suffering from an acute exacerbation of a chronic cardiac or cardiovascular disease and are therefore unable to withstand the rather prolonged surgical ordeal necessarily required for the relief of an obstruction in a deep-seated vessel such as the common or external iliacs (Table II)

TABLE II

Anæsthesia	Number of Cases
General (ether, nitrous oxide, ethylene, sodium amytal and chloroform)	19
Local	67
Spinal	14
Local supplemented by general	1
Spinal supplemented by general	1
Anæsthesia not stated	17
No operation	10
	—
Total	129

Analysis of deaths with reference to type of anæsthesia shows that it had very little effect on the ultimate operative results

In analyzing the deaths in our collected group of cases with reference to the type of anæsthesia used we find that it had no particular bearing on the results of the operation. Twenty cases were operated on under general anæsthesia, such as ether, nitrous oxide, chloroform, ethylene, *etc*. Thirteen of these cases died. In five death occurred a week after the operation, seven died many hours after, and only one died within one hour after the operation had started.

Almost all cases that were operated on under general anæsthesia were those in which the access to the vessel was difficult, making the operative risk greater. In five the embolus was in the aorta and six in the deep femoral. The operative results would have probably been the same if local or spinal anæsthesia would have been used. There is no evidence in the clinical record to show that the form of anæsthesia had any direct bearing upon the ultimate operative results, and we are therefore justified in assuming that the general anæsthesia was not of the contributory causes to the fatal outcome in those cases.

*Technic of Operation*—Arterial embolectomy is a comparatively simple operation, particularly in the vessels of the extremities. The exposure of the artery is quite a simple process and the localization of the obstructing clot is usually not difficult, since the absence of pulsation below the obstructing point and its presence above that is a most reliable guide. In most instances, the obstructing clot can be easily palpated even before secondary thrombus formation has taken place.

The most common site for the location of an embolus is at or near an arterial bifurcation, or at a point of a sudden narrowing of the arterial canal where the embolus becomes arrested in its flow through the blood-stream. After the site of the obstruction is located the vessel is carefully separated from its contiguous structures and lifted out from its bed by the usual surgical procedure. From this point on every step of the operation should be scrupulously carried out in accordance with the Carrel method of vessel surgery. One rubberized clamp should be applied above the point of obstruction. It is not advisable to apply a clamp below the obstruction, on account of the risk of grasping the thrombus which formed below, thus crushing it and forcing the clots down to the lowermost part of the vessel. The arteries which come off at the bifurcation point should also be clamped to prevent retrograde hæmorrhage.

My own procedure consists of constricting the vessel by ordinary flat sterilized tape, saturated in a 2 per cent sodium citrate solution. One half-twist of the tape, combined with gentle upward traction on the vessel by an assistant, is usually effective in causing sufficient circulatory constriction, permitting the incision in the artery to be made without any loss of blood. Another advantage of this method over that of the clamps is the ease with which the circulation of the vessel can be controlled after the incision in the artery is made and the clot evacuated. Merely twisting and untwisting the tape and slight upward traction is sufficient to obstruct or release the flow of blood in the artery. There is also less likelihood of additional injury to an already damaged blood-vessel wall that may be brought about by tightly constricting metal forceps applied below the embolus. The application of vaselined gauze to the operative field, as recommended by some, is not practical since it makes the operative area very slippery and seriously interferes with the manipulation of the surgeon. Instead of the vaseline gauze flats saturated in a 2 per cent sodium citrate solution should be used. All instruments and the surgeon's gloved hands should also be frequently rinsed in the solution so as to prevent blood-clotting.

The incision in the vessel should be made longitudinally, a little above the obstructing point. When the embolus is lodged near the bifurcation of an artery, great caution should be exercised in placing the incision away from that point. Extreme narrowing of the vessel lumen may take place in an already constricted arterial channel, and marked interference in the collateral circulation may result after the incisions are closed if these two points are disregarded.

The segment of artery to be incised should be supported by the index finger of the left hand. Incise the anterior vessel wall with a fine scalpel, exercising great care not to injure the intima of the posterior or lateral vessel walls by the point of the scalpel. The clot is usually evacuated spontaneously, or it may be necessary to dislodge it by digital pressure upward against the vessel wall. A very fine thumb forceps without teeth, dipped in sodium citrate solution, may be introduced into the vessel lumen and the clot extracted.

After the clot is evacuated the constriction of the vessel above the incision may be released and the blood allowed to flow freely. If the obstruction is completely relieved the blood usually spurts freely and occasionally some small fragments of the clot that may have remained in the vessel above the incision are forced out by the stream of blood, but if there is no free flow of blood the assumption is that there is another clot in the artery above the incision or in its parent trunk obstructing the circulation. An attempt should then be made to dislodge it either by another incision into the vessel higher up or by aspiration through a soft catheter introduced into the artery.

Very frequently a thrombus forms below the point of occlusion, extending for a considerable distance into the lumen of the distal portion of the artery and occasionally also blocking the arterial channel of a branching vessel at that point, seriously hindering the establishment of collateral circulation. It is therefore important to determine, before the primary incision is closed, the presence of such thrombi and dislodge them either by very light upward digital massage, by aspiration or, if necessary, through a secondary incision made distal to the primary one. Before making this incision, the vessel should be constricted below that point so as to avoid the dislodgment of clots to the periphery of the vessel or its branches.

After having determined the condition of the arterial canal above and below the obstructing point, and being reasonably certain that no further obstruction is present, particularly at the proximal portion of the artery, as indicated by the free spurting of blood synchronous with the pulse beat, the upper portion of the artery should again be constricted and the incision closed. The needles should be of the finest size, threaded with fine silk, dipped in sterile vaseline, albolene or 2 per cent sodium citrate solution. The suture should be inserted close to the edges of the incision so as to avoid inversion of the edges, thus narrowing the arterial canal. For the same reason one should avoid too close and unnecessary suturing. The soft parts are then closed in the usual manner. The limb is to be kept at perfect rest, and heat applied. Massage or passive motion should be entirely withheld during the first few post-operative days.

The first case that came under my observation was that of an embolus of the brachial artery in a woman suffering from diabetes and arteriosclerosis. When seen by me thirty-six hours after onset of disease there was no pulsation in the brachial artery beginning at the middle part of the arm. At that point a very distinct nodule about a half-inch in length could be felt. This nodule, which was apparently in the vessel wall, could be moved in an upward and downward direction. Distinct arterial pulsation could be felt above that point and none below. The diagnosis of brachial embolus was made and arteriotomy under local anæsthesia was done. The clot was extracted and the vessel sutured according to Carrel's method. Unfortunately, the patient developed a cerebral embolus, followed by death twelve hours later. A report of this case and also of two other arteriotomies subsequently performed by me were published in the May, 1928, issue of the *ANNALS OF SURGERY*.

A third case, included in this paper, is that of an embolus lodged in the left common iliac. It illustrates very strikingly, from its etiological and clinical course, also from the operative procedure, the most salient points pertaining to our subject.

*CASE I—Embolus of Left Common Iliac*—M. B., female, aged thirty-five years, was admitted to the Newark Beth Israel Hospital February 15, 1932, and expired February 18, 1932. The admitting diagnosis was an acute exacerbation of a chronic endocarditis with embolus in the left iliac artery. The woman was very sick when admitted to the hospital. Her condition was of such an emergency nature that immediate operation was done.

*Past History*—Patient had suffered from chronic endocarditis with frequent remissions and exacerbations for many years. Several weeks before her admission to the hospital, she had an acute exacerbation of her cardiac condition, which confined her to bed. She was running a septic temperature during that time, and three days before her admission she developed symptoms of cerebral embolism, followed by right-sided hæmiplegia. About ten hours before admission she was seized with severe sharp pain in the left groin, radiating down to the entire thigh and leg. This was followed by a numbness, coldness and cyanosis of the toes. She was unable to move the leg. Dr. Eugene Merliss, who saw the patient in the afternoon of the same day, recognized the condition and advised her immediate removal to the hospital. She was very emaciated. She seemed to be markedly dehydrated and there was a marked impairment of speech, and inability to move her right arm and leg. The skin over the left thigh and leg was cold. Moderate cyanosis of toes and dorsum of foot. The remaining part of the limb had a marble-like appearance. There was marked diminution of sensation all along the leg and thigh, and marked impairment of motion. The circulation of the right foot and leg also seemed to be moderately impaired, although pulsation of femoral and popliteal was very distinct. Toes also seemed to be slightly cyanosed.

There was no pulsation of the dorsalis pedis, popliteal or femoral arteries, on the left side. A very faint pulsation was felt immediately above Poupart's ligament, along the course of the external iliac artery. Three inches above that, distinct pulsation could be felt on deep pressure, at about the point of the aortic bifurcation into the two common iliacs. Auscultation, with the stethoscope, confirmed the condition. A distinct pulsation could be heard at the aortic bifurcation. No pulsation at Poupart's ligament or below that. On the right side, the pulsation of the popliteal and femoral arteries was very distinct. She complained of very severe pain in the left thigh and leg. The condition of the heart was very poor. Temperature ranged between 101° to 103°. The diagnosis of an embolus of left external iliac was evident. Fourteen hours after onset, under spinal anesthesia, an incision was made parallel to Poupart's ligament. On the left side the external iliac artery was identified and followed up to its bifurcation into the external and internal iliac. There was no pulsation palpable or visible at the external iliac, near Poupart's ligament. Just above the bifurcation of the left common iliac into its external and internal branches, a large clot could be felt at that region. There was moderate pulsation above that point and none below. The left common iliac was exposed to view and followed up to its origin from the aorta. Two sterile tapes were applied above the bifurcation of the artery, one above the clot and one below.

An incision about one-half inch long was then made in the common iliac artery and a large clot was evacuated. Another incision was then made immediately above Poupart's ligament in the external iliac artery and some more clots were expressed. The intervening segment of vessel between the upper and lower arterial incisions was irrigated with a 2 per cent sodium citrate solution.

Digital palpation of the femoral artery through an extended incision downward showed that vessel to be thrombosed. With upward massage a number of small clots

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were expressed through the lower opening of the common iliac artery. The tapes were then released and blood spurted freely through the upper arterial incision. The vessel walls were then sutured with a fine-eyed needle threaded with vaselined silk. The lower incision was still clamped during this process. After closure of the upper incision, the tape from the lower incision was then removed and blood flowed freely from that opening, but the volume and force were poor. Suspecting that the obstruction was not completely relieved, the sutures of the upper incision were removed but no other clots or thrombi above the upper incision were found. On releasing the tape again, blood spurted very freely from the upper incision. Both incisions in the vessel were then closed. There was distinct pulsation below the bifurcation of the common iliac in both vessels—the internal and external—but the pulsation was not transmitted freely to the femoral artery. It was not visible nor palpable. Further arterial exploration was deemed inadvisable and the abdomen was closed.

Patient was kept first in Trendelenburg position on account of the type of anaesthesia and also on account of the extreme shock in which the patient was in. There was no apparent restoration of circulation on the following day. Pulsation of the vessels of the right leg was very distinct but no pulsation could be elicited either by palpation or auscultation at the femoral artery. The general condition of the patient remained very poor. Temperature rose to  $103^{\circ}$ . She was incoherent, very restless and in spite of external applications of heat to the limb, the discoloration of the leg increased and signs of gangrene set in. Temperature rose to  $106^{\circ}$  on the second day. Pulse became rapid and also imperceptible. She was cyanosed and dyspnoeic and complained of severe pain in both legs. The circulation of the other foot was distinctly impaired. That was probably due to a general circulatory failure, because the pulsation of the right femoral and popliteal continued to be of good quality. The patient died on the third day following operation. Permission for autopsy was not granted.

I am also including case histories of two other patients that came under my observation recently. These histories are relevant to our subject because they prove definitely the futility of the late operation, the inevitable gangrene following non-operative intervention, and the vascular changes taking place in the lumen of the artery after the lodgment of the embolus.

CASE II—J. E., white, male, aged thirty-six years, was admitted to the Newark Beth Israel Hospital May 15, 1928, complaining of severe pain in the left leg. Five days previously, while playing ball, he was seized suddenly with severe pain in the left leg. He stated that he felt a knotting of the muscles so that he was unable to stand up. Within ten minutes the leg became ivory-white, followed by tingling, numbness and limited motion. He was operated on two days later under gas anaesthesia. From the time of operation up to the time when he came under our observation, the gangrene progressed very rapidly and the leg became almost completely black. The pain persisted.

His past history showed that he was treated at our hospital from November 23, 1926, to January, 1927, for auricular fibrillation and some cardiac decompensation. There was marked improvement in his condition at the time of his discharge (January, 1927), and from that time on until the present onset, he had neither complained of any symptoms or shown any signs referable to his cardiac condition, although his work was moderately hard. He was a rugged and well-developed adult. There is neither dyspnoea nor cyanosis and no evidence of shock. He looked moderately toxic. The heart is immensely enlarged. There is heaving of the precordium. The apex impulse is in the seventh interspace in the mid-axillary line. The heart sounds are markedly irregular. There is a loud blowing systolic murmur transmitted to the back. There are other murmurs but the exact time of their occurrence is faintly heard in the aortic and pulmonic areas. Aortic second sound is greater than pulmonic second sound.

There is a fresh surgical incision on the posterior aspect of the left leg extending



from the popliteal space to the junction of the middle and upper thirds. There is marked swelling about this area. No crepitation on pressure but there is exquisite tenderness. There is discoloration commencing abruptly at the middle of the leg and involving the entire portion of the extremity below it. The toes are black and cold. The dorsalis pedis arterial pulsation cannot be felt. Above the ankle, the leg shows splotchy areas of black, brown and gray. There is a foul odor coming from the wound. Movement is impaired because of pain. Pulsation of the left femoral artery is distinctly felt just below Poupart's ligament and can be followed down to the saphenous space. No pulsation in Hunter's canal. Some enlarged glands can be felt just below the groin. Pulsation of popliteal artery not felt.

Temperature at time of admission, 103, urine very slight trace of albumin, blood count 10,000 leucocytes, with a differential count of polymorphonuclears, 78 per cent, lymphoblasts, 22 per cent, haemoglobin, 78 per cent, red blood-cells 3,800,000. With a diagnosis of gangrene of left leg of embolic nature and auricular fibrillation with massive cardiac hypertrophy amputation at the thigh was done. Patient made an uneventful recovery.

*Pathological description of leg*—(Dr Asher Yaguda.) Left leg amputated at the junction of the middle and lower thirds. The skin of the foot and lower half of the leg is of a purplish hue and there is a dry gangrene of the toes and the skin covering the dorsum of the foot and the heel. The upper border of the cyanotic discoloration does not end sharply, but gradually shades off into the surrounding normal skin. The whole leg appears mummified.

There is a gaping incision over the posterior aspect of the leg which extends from the popliteal fossa downwards for 19 centimetres over the gastrocnemius muscle. The wound is not closed by sutures and the muscle bulges through the incision presenting a pale grayish oedematous appearance. The incision extends through the gastrocnemius and the soleus

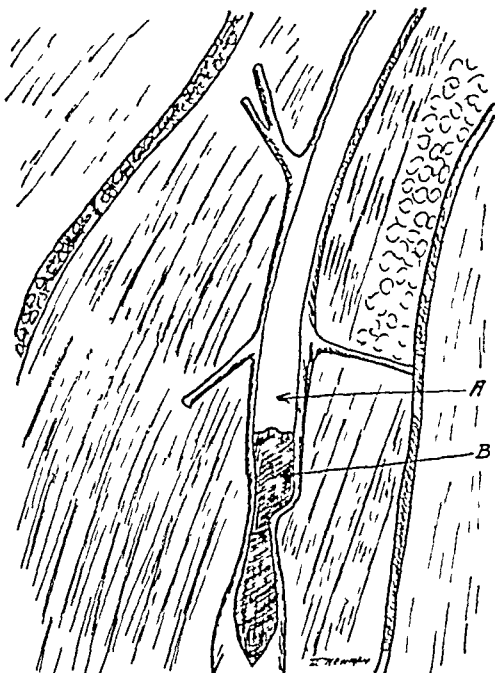


FIG. 1.—Diagrammatic sketch from photograph of femoral artery. A—Injection mass. B—Thrombus.

muscles and exposes the posterior tibial artery.

Upon opening the popliteal artery, there is seen to be a mixed red and white thrombus filling the vessel up to the point of amputation. This thrombus is loosely but definitely attached to the intima of the artery. At the point of bifurcation of the popliteal artery into anterior and posterior tibials is lodged an embolus which saddles the bifurcation (Figs 1 and 2). This embolus is composed of a white parietal thrombus. The artery above this is dilated. Below this point the arteries are empty and there is a marked venous engorgement due to venous backflow. The popliteal artery and both tibials show slight atherosclerosis but are otherwise negative.

CASE III—A R, male, aged sixty-two years, admitted to the Newark Beth Israel Hospital April 1, 1932. He had suffered from cardiac disease for many years. For the past several months he was unable to do any work, being compelled to remain in bed most of the time. Several days previous to his admission to the hospital, he was seized with sudden sharp pain in his right leg. This was followed by a tingling sensation, numbness and inability to move the leg. The color of his skin assumed a marble-like appearance. No definite diagnosis was made until three days after the onset of his condition, when symptoms of extensive gangrene appeared.

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When seen by me in consultation with the attending physician, the foot was entirely gangrenous. Extensive dark-bluish blotches were present on the outer and anterior aspect of the leg. No pulsation could be felt in dorsalis pedis or popliteal vessels. There was distinct pulsation of the femoral artery immediately below Poupart's ligament but none below that point. The circulation of the other leg also appeared somewhat impaired. The diagnosis of embolus of the right femoral was made. Since the gangrene was far advanced, amputation was advised.

A disarticulation of the thigh was done under spinal anæsthesia. Patient reacted



FIG. 2.—Photograph of amputated right leg with femoral artery cut open to show A—Injection mass B—Thrombus. Arrow points to definite constriction and occlusion of the blood vessel.

well from the operation but died suddenly a week later probably from coronary thrombosis.

The autopsy report and the pathological findings obtained from the dissection of the leg and thigh, as submitted to us by the pathologist, Dr. Asher Yaguda, show several points of interest, relevant to this subject. The specimen consists of the right lower extremity which has been disarticulated at the hip-joint. At the disarticulated end the femoral artery is thickened and shows calcified plaques involving the intima and constricting the lumen. Upon opening the femoral artery, about three inches from the

severed end is a well-formed thrombus which is of recent origin, red in color. A few inches from the beginning of this thrombus and at about the point of bifurcation of the deep and superficial femoral is a constricted portion with a saddle thrombus which shows beginning organization. The artery below this including the popliteal shows a marked atherosclerosis with narrowing of the lumen and thickening of the wall.

*Microscopical Examination* of sections of the vessel at several levels shows a thickening of the intima with areas of calcification and atheroma formation. The lumen is markedly constricted. Examination of the thrombus shows it to be embolic in origin as can be ascertained from the fact that it is a parietal thrombus which is undergoing some organization. (Figs 1 and 2)

The heart weighs 850 grams. There is a marked hypertrophy of the left ventricle with an area of softening involving the posterior wall of the left ventricle at about its upper middle portion. Injection of the vessels with barium shows an atherosclerosis involving both the right coronary artery and the left coronary artery. This atherosclerotic process is particularly apparent in the right circumflex coronary artery after it has given off its lateral ramus and there is a definite blood-clot to be seen at this location. The circulation through the posterior descending ramus therefore is shut off and also in an additional branch which supplies the middle portion of the posterior surface of the left ventricle at the site of softening. The area of softening is much smaller than the area supplied by the occluded right coronary. This is due to the fact that a large number of collateral anastomotic branches have developed. Anastomotic branches can be seen between the capillary and precapillary branches of the same coronary and branches of the right and left coronary arteries. All of the main branches of the coronary artery show some tortuosity and are distinctly narrower than the normal artery would be.

The descending aorta shows a marked atheromatosis and arteriosclerosis. Some of the atheroma show definite evidence of ulceration. The common iliacs are sclerotic and tortuous. On opening the right common iliac a pale thrombus is seen immediately above the bifurcation and extending into the right common iliac and femoral. The thrombus is firm and pale and shows beginning evidence of fibrin formation. The vessel at this site shows marked atheromatosis and arteriosclerosis.

The difference in the condition of the blood-vessels in the two amputated legs, as described in the pathological reports, definitely indicates that early operation in those cases not associated with advanced arteriosclerosis is likely to give a much higher percentage of cures, since the continuity of the arterial canal is more likely to be restored once the obstructing embolus with its associated thrombus is removed. Whereas in cases of arterial emboli associated with advanced arterial sclerotic changes, the lumen of the vessel may be markedly constricted as shown in Case III. Extraction of the obstructing embolus may produce temporary partial circulatory restoration, but this is usually followed by a rapid reformation of a long thrombus which may fill up the lumen of the artery proximal and distal to the point where the embolus was lodged. If the embolus is lodged at the bifurcation into two main branches, the thrombus may extend into both branches, thus preventing the establishment of any collateral circulation. As we shall show later, this assumption seems to be supported by a comparative analysis of the end-results obtained in the two types of cases included in this study.

*Statistical study of cases collected from literature*—The total number of cases collected from the literature, for the purpose of studying the end-results, is 129 (Table III). The average age was forty-nine years, females

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and males almost the same The youngest was a child, seventeen months old, operated on for an embolus in the subclavian artery, supposed to have followed serum treatment for pneumonia The oldest was a woman, eighty-two years old, who suffered a paralytic stroke previous to the onset of an embolus in the femoral artery, which was removed Patient was alive and well one year after the operation

TABLE III

Total number of cases	129
Females	72 or 56 4%
Males	55 or 43 3%
Sex not stated	2
	—
Total	129
Average age (based on 117 cases)	49 0
Female	50 9
Male	49 5
Youngest	17 months
Oldest	82 years

	Male	Female
Youngest	17 months	27 years
Oldest	78 years	82 years

The age incidence, estimated in decades, shows that the frequency of its occurrence is constantly on the increase between the decades of 30 and 40, and 60 and 70, being most common between the ages of 50 and 60 (Table IV)

TABLE IV

*Ages in Decades*

1-10	1
10-20	1
20-30	6
30-40	23
40-50	26
50-60	32
60-70	28
70-80	9
80-90	1

There is very little difference in age incidence between the two sexes

Of the vessels affected, the most common is the femoral (52 or 40 3 per cent) Next in frequency are the brachial and common iliacs (Table V) The least commonly affected are the radial and posterior tibial

*Aorta*—There are eleven cases of aortic obstruction by embolus in this group, six of which are males and five females The ages vary from thirty-seven to sixty-eight Of these eleven cases, three were not operated upon

TABLE V  
*Vessels Affected*

Aorta	11 cases
Subclavian	2 cases
Axillary	7 cases
Brachial	19 cases
Radial	1 case
Common iliac	18 cases
Internal and external iliac	5 cases
Femoral	52 cases
Popliteal	12 cases
Anterior and posterior tibial	2 cases
Total	129 cases

Symptoms of obstruction, however, were very distinct and autopsy showed a movable clot above the aortic bifurcation in every case. Two of these patients died within twenty-four hours after the onset of the disease, and one died from a terminal pneumonia, seven days later. Of the eight operated cases, there were two cures, one was operated upon two hours and the other six hours after the onset of symptoms. One of these operated cases was well one year after the operation and the other died three weeks later from embolism of the right innominate artery, but the circulation was completely restored in both legs immediately after the operation and remained in good condition until death. In the six cases that died operation was performed between a period varying from one hour to fifty hours. Post-mortem examination in three of these cases showed obstructive thrombi at the aortic bifurcation in two, and thrombus in external iliac and femoral artery in one.

The incidence of aortic emboli in the male in this group is greater than that of the female, whereas in our total number of cases, the female element predominates (seventy-two of the former to fifty-five of the latter). E. Hesse,<sup>26</sup> in a study of seventy-two cases of aortic obstruction by thrombi or emboli, questions the previously accepted belief that females are more likely to suffer from aortic obstruction than males. In a study of his group of cases, he finds that the male element predominated in embolic obstruction, twenty-five out of forty-three cases (57 per cent) were men and eighteen (43 per cent) were women. On the other hand, out of seventeen, aortic obstruction caused by thrombus formation within the vessel, five (29.4 per cent) were men and twelve (70.5 per cent) were women.

## CASES OF AORTIC EMBOLISM

CASE I—Male, aged fifty-nine. Valvular heart-disease. Patient was not operated on, although the diagnosis was definite. Died three days after onset of disease. Autopsy showed gangrene of one-half of the intestinal tract. Freely movable embolus was found at the bifurcation of the aorta. Many soft thrombi were found distal to the embolus, in the iliac and femoral vessels.

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CASE II—Male, forty-one years old, suffered from cardiac disease for many years. Previous operation for goitre, twelve years ago, laparotomy for ulcer of stomach, five years ago, palpitation on exertion last two years. Was seized with a sudden sharp pain on the morning of December 1, 1929. The pain was very sharp, mostly in the sacral region, radiating to both legs. Legs became blue and cold, and the pain increased in severity. He was operated on six hours after the onset of symptoms under chloroform and ether anaesthesia. An embolus was extracted, the circulation restored and patient dismissed in four weeks. Two and one-half weeks later, he developed a thrombosis of the right lower leg and symptoms of pulmonary embolism. These symptoms subsided within eight weeks. Five months after operation, there was no cyanosis or oedema of leg. One year later, the general condition was good, complaining only of pain in the right calf, after walking a long distance.<sup>15</sup>

CASE III—Female, aged fifty-six, suffered from myocarditis and mitral regurgitation. Operated on fifty hours after onset of symptoms under ether anaesthesia. Result: No restoration of circulation. Death twenty-four hours after operation.<sup>41</sup>

CASE IV—Male, aged thirty-seven, suffered from heart-disease. Was operated on for an embolus at the bifurcation of the aorta twelve hours after the onset of the disease. Patient died twelve hours after operation. Post-mortem examination showed dark red thrombi extending into external iliac and femoral arteries.<sup>46</sup>

CASE V—Female, aged sixty-two, suffered from diabetes, thyrotoxicosis and marked cardiac disturbance. Patient was previously operated on for an embolus of the right femoral, four hours after the onset of symptoms. On the fifth day following operation, patient felt an agonizing pain in the middle of the back and both legs. The skin, about two fingers breadth, above the umbilicus, showed a blotched and marble color. No pulsation could be felt in the vessels of the thighs and legs. The operation was performed within one hour after onset of symptoms under spinal anaesthesia. The operation was done transperitoneally, through a mid-line incision. Aortic bifurcation was exposed and a clot was extracted. Pulsation felt soon after operation, in both legs. Next morning, pain in lumbar region returned, and patient died within twenty-four hours.<sup>50</sup>

CASE VI—Female, aged fifty-eight, suffered from cardiac decompensation. Operated on twelve hours after onset of disease. Embolus found at bifurcation of aorta. Anaesthesia: Local supplemented by general. There was no restoration of circulation, and patient died soon after.<sup>61</sup>

CASE VII—Female, aged thirty-seven, suffered from cardiac decompensation, which was aggravated by pregnancy of eight months' duration. She was operated on under general anaesthesia. Bilateral incisions were made over the femorals and iliac vessels. An attempt was made to extract the clot, which was only partially successful. There was no restoration of circulation and patient died three days after operation. Autopsy showed an obstructive thrombus, about  $1\frac{1}{2}$  inches in length, at the bifurcation of the aorta. There was gangrene of the left foot and leg and right foot. This partial circulatory restoration has probably taken place through some collateral circulation, which was established after the embolus had lodged in the aorta.<sup>63</sup>

CASE VIII—Male, aged fifty-seven, convalescing from a bronchopneumonia, complained of abdominal pain simulating appendicitis, followed by coldness of both legs and loss of motion. Admitted to the hospital on the same day with a diagnosis of embolism of the abdominal aorta. A median laparotomy incision was made under ether narcosis, the aortic bifurcation was exposed and an incision  $3$  by  $\frac{3}{4}$  centimetres was made into the vessel and the embolus was spontaneously expelled through the incision. Both iliac arteries were explored and found patent. Patient died on the following day and autopsy showed that the embolism was caused by a thrombus from an ulcerative endocarditis.<sup>66</sup>

CASE IX—Male, aged forty-five, gave a history of repeated attacks of gall-bladder colic and jaundice, some suspicion of cardiac disease. Cholecystectomy was done under spinal anaesthesia. Five weeks after the operation patient felt a sudden pain in the lower part of abdomen, radiating to the flanks. This was followed by tingling and

numbness of both legs, and loss of motion. The skin assumed a marble-like color, diagnosis of embolism at aortic bifurcation was made. Patient sank rapidly into coma, and died the following day. No embolectomy was done. Post-mortem examination showed a large clot at the aortic bifurcation."

CASE X—Female, aged forty-eight cardiac. Developed sudden pain in the right groin, back, and both lower limbs, gangrene in right leg, followed by amputation. Died six weeks later of terminal pneumonia. Autopsy showed embolus at bifurcation of aorta, extending into both common iliacs, causing complete obstruction on right, and partial on left.<sup>61</sup>

CASE XI—Male, aged sixty-eight, operated on for hernia. Five days after operation, developed auricular fibrillation. Fifteen days after operation, there was a sudden pain in right foot, followed by marble-like appearance of leg and foot. No tibial or femoral pulsation could be felt, left limb was also cyanosed. Operation performed two hours later under sodium amylal anesthesia, an abdominal incision was made, five-inch blood-clot was milked down to the femoral vessels. This was followed by a slow stream of blood, but there was no pulsation after the closure of the vessel. Again milking the common iliac vessel near the aorta, the embolus was shot out, followed by forcible stream of blood. Circulation was restored in both feet immediately after the operation. Three weeks later the patient went into coma. There was no pulsation of the right subclavian and right carotid. Diagnosis of embolus in the right innominate artery was made and patient died ten hours later, no autopsy.<sup>62</sup>

*Arteries of the Upper Extremities*—For the sake of brevity, we are including under the classification of arterial embolectomies performed on the blood-vessels of the upper extremity—the subclavian, axillary, brachial and radial arteries. Of the twenty-nine cases in this group twenty-seven were operated upon. In seventeen (63 per cent) of these cases, the circulation was completely restored and in two (7.4 per cent) there was incomplete circulatory restoration, necessitating amputation of the index finger in one and thumb in another. The patients were alive and well one year or more after operation. Two of the nineteen brachial cases that were not operated upon slowly regained sufficient circulation to maintain the function of the entire extremity.

#### VESSELS OF THE UPPER EXTREMITY—SUBCLAVIAN

CASE I—Left subclavian. Male, seventeen months old suffered from double pneumonia for which 50 cubic centimetres of Mulford's antipneumococcus serum was given. Similar injection was given on the fourth day of the illness. This was followed by convulsions and marked prostration. The left arm appeared livid and cold, from the fleshy part of the shoulder down to the fingers. There was a diminution of sensation, and marked claw-like contraction of the fingers. Diagnosis of embolism of subclavian was made, operation was performed fifteen hours after onset under chloroform anesthesia. Incision was first made in the brachial but there was no active bleeding. Aspiration of the upper part of the artery was carried out, then a ureteral catheter was introduced into the artery for about four inches, and on withdrawal a clot 3 centimetres long was brought out, and the circulation was at once restored. The incision in the vessel was closed. The child had no fever and there was good circulation of the hand. Patient died two days later from what the author calls "pleuropulmonary sepsis." No autopsy.<sup>63</sup>

CASE II—Left subclavian. Female, aged sixty-two, previously operated on for empyæma of gall-bladder, followed by lung infarct. Operation was performed five hours later. The embolus was extracted from subclavian vessel, followed by complete restoration of circulation and function of arm. Follow-up six months later showed that no

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radial pulsation could be felt on the affected side, and no blood-pressure reading could be obtained, either by auscultation or palpation<sup>25</sup>

### VESSELS OF THE UPPER EXTREMITY—BRACHIAL CASES

CASE I—Embolus of right brachial Sex not stated, patient's age, forty-six Cardiac disease and arteriosclerosis Had an amputation of leg one week previous Three weeks after onset, pain in the thigh, which was probably also due to an embolus Seven days after this operation, patient developed sudden pains above right elbow, which extended rapidly into the entire forearm, followed by complete loss of function of hand and forearm<sup>21</sup>

CASE II—Embolus of right brachial Male, aged sixty-three, tuberculous Operated on twenty-four hours after onset of symptoms under local anæsthesia No pulsation of radial at the wrist after operation Gangrene developed and amputation of arm was done ten days later, followed by good immediate post-operative recovery Died three days later from cardiac dilatation, no autopsy but dissection of amputated arm showed thrombus in brachial artery and thrombosis in the radial<sup>14</sup>

CASE III—Embolus of left brachial Male, aged eleven Compound fracture of the left humerus Time of operation or type of anæsthesia not stated Embolus from radial was extracted Author states that after removing the clot from brachial artery, he stopped the bleeding from the vessel by application of hot sponges, and no arterial sutures were inserted There was complete restoration of circulation and function, probably through collateral circulation<sup>12</sup>

CASE IV—Side not stated Male, aged fifty-seven, suffered from chronic endocarditis with mitral murmur Operated on previously for gangrene of right leg due to embolus at femoral artery, not diagnosed until one week later Patient developed embolus of brachial for which he was operated on seven days later under novocaine anæsthesia The pulsation and dilatation of the brachial artery below the incision were immediately restored Circulation seemed to be reestablished (successfully) Died one week later from cerebral and common iliac emboli<sup>9</sup>

CASE V—Side not stated Male, aged thirty-four, operated on previously for acute appendicitis Embolus extracted two hours later under novocaine anæsthesia This was followed by gangrene of thumb requiring amputation of its terminal phalanx, with marked neurological disturbance of limb, which ultimately cleared up under physiotherapy<sup>9</sup>

CASE VI—Side not stated Male, aged sixty-six, suffered from cardiovascular disease Operated for hydrocele nine days previous to the onset of the embolism The embolus was extracted under local anæsthesia The time elapsed between onset of symptoms and operation not stated There was complete restoration of circulation and function Early operation is emphasized for a successful cure by the author<sup>7</sup>

CASE VII—Embolus of left brachial Female, aged forty-six, diabetic, operated on three days after onset of symptoms At operation, under novocaine anæsthesia, the forearm was cold and insensible, the hand was shriveled and no pulsation below the brachial artery There was a bifid thrombus extending into radius and ulnar Gangrene developed, amputation ten days later<sup>2</sup>

CASE VIII—Embolus of right brachial Male, aged fifty-two, coronary disease Operated for ruptured gastric ulcer Five days after operation, suddenly began to complain of pain in left shoulder and arm Six hours later right arm suddenly turned cold and pulseless, operated one hour after that, embolus from right brachial artery extracted, secondary thrombi in brachial and axillary There was no return of pulsation, patient died ten hours later from multiple emboli throughout the body No autopsy<sup>68</sup>

CASE IX—Embolus of right brachial Female, aged sixty-nine, suffered from cardiac decompensation and hypertension Sudden severe pain in right arm Operated on twelve hours later under novocaine anæsthesia No pulsation of radial artery after operation Five days later circulation improved, ulnar pulsation felt Developed cerebral



embolus on left side, on sixth day with right hemiplegia. Circulation in left arm seemed normal. Patient died seven weeks after operation.<sup>50</sup>

CASE X—Left brachial embolus. Female, aged twenty-seven, cardiac disease. Operated on three hours later under local anaesthesia. Embolus two centimetres long removed, no radial pulsation felt for four hours. Next day there was pulsation. Patient died from endocarditis on seventeenth day. Autopsy confirmed the clinical diagnosis of the cause of death. There was no trace of thrombus reformation in brachial.<sup>50</sup>

CASE XI—Left brachial embolus. Female, aged forty-six, suffered from cardiac disease. Had a previous amputation of leg above the knee, following embolus of popliteal artery. Operation on brachial was done six hours after onset under local anaesthesia. Two weeks after operation, no radial pulsation. Two months later atrophy of muscles, weakness of forearm, *no radial pulsation* but no gangrene.<sup>51</sup>

CASE XII—Right brachial embolus. Male, aged thirty-nine, symptoms of tuberculosis and convalescing from an attack of pneumonia. Two weeks after crisis, developed acute pain in right arm during the night, followed by exquisite tenderness, and anaesthesia of the finger tips. Right radial pulse absent. Diagnosis of brachial embolism was made. Patient died three days later without any operation.<sup>51</sup>

CASE XIII—Left brachial embolus. Female, aged seventy-two, cardiac. Seized with sudden pain in left arm, followed by flexion contraction of the fingers and inability to move them. One week later, patch of gangrene appeared upon the back of the left forearm. No operation was done but all symptoms, with the exception of muscular contraction, disappeared within two months after onset of disease. Patient died subsequently from cerebral embolism.<sup>52</sup>

CASE XIV—Side not stated. Male, aged seventy-seven, suffered from hypertension. Operated on four hours after onset of disease, type of anaesthesia is not stated. There was complete circulation and function.<sup>52</sup>

CASE XV—Side not stated. Male, aged seventy-three, cardiac. Operated on six hours after onset of disease under local anaesthesia. This was followed by complete restoration of circulation and function. Patient well one year later, but there was no pulsation ever felt in brachial or radial arteries. The circulation was evidently carried on through collateral branches.<sup>52</sup>

CASE XVI—Right brachial embolus. Age and sex not stated. Etiology, cardiac. Time elapsed not stated. Patient was operated on under local anaesthesia, followed by successful restoration of circulation and function. There was no radial pulse felt at any time after the operation. The circulation, in this case, was also carried on through collateral branches.<sup>53</sup>

CASE XVII—Right brachial embolus. Male, aged forty-six. Etiology, alcoholic? Other etiology is not stated. Operated on five hours after onset of disease under local anaesthesia, followed by partial restoration of circulation. There was gangrene of thumb and index finger requiring amputation.<sup>54</sup>

CASE XVIII—Right brachial embolus. Male, aged seventy-eight, suffered from syphilis and cardiac disease. Operated on two hours after onset of symptoms under local anaesthesia. Restoration of pulsation in brachial and radial, good function. Died thirteen weeks after operation from some other cause.<sup>54</sup>

CASE XIX—Right brachial embolus. Female, aged fifty-eight, suffered from diabetes and cardiovascular disease. Operated on thirty-six hours after onset of disease under brachial block anaesthesia. Died six hours after operation from cerebral embolism.<sup>55</sup>

#### VESSELS OF THE UPPER EXTREMITY—AXILLARY CASES

CASE I—Side not stated. Female, aged seventy, suffered from cardiac decompensation and arteriosclerosis. She was operated on two hours after onset of symptoms under local anaesthesia. The circulation in the arm was completely restored but the patient died a cardiac death one week later. Autopsy showed wound well-healed, no evidence of gangrene in the affected arm.<sup>2</sup>

## ARTERIAL EMBOLECTOMY

CASE II—Embolus in left axillary artery Male, aged forty-two, operated on for hernia The embolus was extracted three hours after onset of symptoms under novocaine anaesthesia This was followed by complete restoration of circulation and function of arm Later on a pulmonary embolism developed, from which the patient recovered Follow-up showed thrombosis of vein of right leg one month after operation There is a suggestion that this case might have been one of a paradoxical embolus, carried from a thrombus of one of the veins to the arterial circulation by a patent foramen ovale There was no history of cardiac disease in this case<sup>30</sup>

CASE III—Side not stated Female, aged fifty-three, suffered from a chronic endocarditis and mitral stenosis She was operated on four hours after onset of symptoms under spinal anaesthesia Pulsation returned at operation in the radial artery but on the following day patient appeared very ill, and although the tips of fingers were cyanosed, there was still some pulsation at the radial Two days later there was excruciating pain in abdomen, followed by incessant vomiting and bloody stools Patient died three days after operation, probably from emboli lodged in the femoral arteries or the aorta No autopsy<sup>31</sup>

CASE IV—Embolus in left axillary artery Female, aged sixty-two, suffered from biliary colic and cardiac disease She was operated on for gall-stones and five days after the operation patient experienced sudden pain in the arm, diagnosis of an embolus in the left axillary artery was made, operation performed under gas anaesthesia, twelve hours after onset, clot removed from the lower end of the axillary Died twenty-four hours later from cardiac failure<sup>32</sup>

CASE V—Side not stated Male, aged sixty, with a history of syphilis and aneurism of aorta Operated on forty-eight hours after the onset of symptoms under local anaesthesia, followed by complete restoration of circulation and function<sup>31</sup>

CASE VI—Embolus in right axillary artery Female, aged fifty-two, suffered from cardiac disease and arteriosclerosis Operated on twenty-nine hours after the onset of symptoms under local anaesthesia, followed by complete restoration of circulation and function Follow-up two months later showed only a weaker pulsation of the radial artery on the operated side<sup>32</sup>

CASE VII—Embolus right axillary artery Female, aged seventy, suffered from cardiac disease Operated on eight hours later under brachial block anaesthesia This was followed by complete restoration of circulation and function, in spite of the fact that the radial pulse was not felt immediately after operation There was some faint pulsation of the radial two days later, normal function of arm and forearm, primary union of wound Sutures removed eight days post-operative Ten days later patient developed an embolus of the right femoral, necessitating reoperation, followed by amputation<sup>33</sup>

### VESSEL OF THE UPPER EXTREMITY—RADIAL CASE

CASE I—Right radial embolus Male, aged thirty-one Etiology unknown Operated on several days or weeks after onset Anaesthesia not stated, slow but complete circulatory restoration Follow-up one year later shows good circulation and function<sup>34</sup>

*Location of Emboli with Reference to Upper or Lower Extremity—Right or Left Side*—Key<sup>35</sup> states that "it is impossible to estimate the relative frequency of the lodgement of an embolus between the right and left side, since the number of cases in which the side is stated is not sufficient to form definite conclusions" In his experience emboli lodge more frequently in the left lower extremity than in the right, and the same thing is true of the upper extremity The likelihood of an embolus being lodged more frequently in the left arm than in the right is explained by some by the difference in origin of the subclavian arteries on either side The right

subclavian arising from the innominate—an embolus finding its way into that vessel, if not arrested at the bifurcation—may enter either into the subclavian or the common carotid arteries, whereas, if the embolus passes by the opening of the innominate artery and enters the left subclavian, it is most likely propelled by the blood-stream into the axillary artery. On the other hand, the direction of the arch of the aorta being from right to left, the innominate artery arising from the right side of the arch is the first vessel that an embolus encounters in its course, after being driven off by the blood-stream from the left ventricle. It would therefore most likely find entrance into the lumen of the innominate artery first. However there is no definite proof that either of these two assumptions has a definite basis.

In our series of twenty-nine cases of embolus of the upper extremity, the right side seems to predominate (Table VI). Emboli lodge more frequently in the vessels of the lower extremity than those of the upper. Of the 129 cases reported in this paper, 100 were in the lower extremity and twenty-nine in the upper. The right lower extremity also slightly predominates over the left. The cause of this marked difference in the incidence of emboli in the vessels of the upper extremity as compared with the lower is not definitely known.

TABLE VI  
*Percentage of Circulatory Restoration in Individual Vessels*

Vessel	No. of Cases	Complete Restoration	Partial Restoration
Aorta	11	2 or 18.0%	1 or 9%
Subclavian	2	2 or 100.0%	none
Axillary	7	5 or 70.0%	none
Brachial	19	11 or 58.0%	4 or 21.0%
Radial	1	1 or 100.0%	none
Common iliac	18	5 or 27.8%	4 or 22.0%
Femoral	52	15 or 28.8%	3 or 5.7%
Int. and ext. iliac	5	2 or 40.0%	1 or 20.0%
Popliteal	12	5 or 41.6%	none
Ant. and post. tibial	2	1 or 50.0%	none

It may not be unreasonable to attribute this difference to the assumption that when an embolus is propelled from the left ventricle into the aorta, the blood-stream is of sufficient strength to carry it rapidly past the orifices of the vessels of the upper extremity, arising from the arch of the aorta to the left curve at the beginning of the descending portion, where it is deflected downward into the abdominal aorta, until it reaches its bifurcation into the two common iliacs.

The respiratory phase, which is present at the time when the embolus passes through the arch of the aorta, is also given by some<sup>25</sup> as a determining factor in the location of the embolus with reference to the upper or lower extremity. Here, again, these are merely assumptions for which definite physiological proof is lacking.

*Arteries of the Lower Extremity*—Of the eighty-four vessels of the lower extremity upon which arteriotomy was performed, twenty-eight (33

per cent ) had complete circulatory restoration and eight (95 per cent ) regained only partial circulation. Comparing the operative end-results in these two groups of cases, it is evident that the operative end-results are much more favorable in the vessels of the upper extremity than those of the lower. 63 per cent of complete restoration in the former, against 33 per cent in the latter.

In comparing the operative end-results of the vessels of the upper and lower extremities with reference to time elapsed between the onset of symptoms and operation, we find that in the vessels of the upper extremity that were operated on between one and four hours, there was complete circulatory restoration in 70 per cent of the cases and partial in 14 per cent, as against 60 per cent complete and 5 per cent partial, in the vessels of the lower extremity. Nine vessels of the upper extremity were operated on between four and twelve hours, with 55 per cent complete circulatory restoration and 11 per cent partial, whereas in twenty-eight vessels of the lower extremity operated on within the same period of time, only 25 per cent complete and 107 per cent partial circulatory restoration was obtained (Table VII )

TABLE VII

*Comparison of Operative Results—the Time Element Being the Same*

Upper Extremity			Lower Extremity		
1- 4 hrs	{ complete	70%	1- 4 hrs	{ complete	60%
	{ partial	14%		{ partial	5%
4- 8 hrs	{ complete	80%	4- 8 hrs	{ complete	30%
	{ partial	20%		{ partial	20%
8- 12 hrs	{ complete	25%	8- 12 hrs	{ complete	22%
	{ partial	none		{ partial	55%
12- 24 hrs	{ complete	66%	12- 24 hrs	{ complete	18%
	{ partial	none		{ partial	13%
24- 48 hrs	{ complete	66 2/3%	24- 48 hrs	{ complete	16%
	{ partial	none		{ partial	none
48-108 hrs	{ complete	50%	48-108 hrs	{ complete	none
2 cases	{ partial	none	2 cases	{ partial	none

The variation in the post-operative end-results between the vessels of the upper and lower extremities becomes greater, in favor of the former, as the time elapsed between onset of symptoms and the operation increases. Of six cases in the upper extremity, operated on between twelve and forty-eight hours, complete circulatory restoration was obtained in four (66 2/3 per cent ). In twenty cases of the lower extremity, operated on during the same period of time, there were only four cases (18 per cent ) in which the circulation was completely reestablished. Two of the vessels of the upper extremity were operated on between forty-eight and 108 hours, and circulation was reestablished in one (50 per cent ), whereas two cases of the lower extremity, operated on within the same space of time, developed gangrene. In two of the cases of the upper extremity, where no operation was performed, there was partial restoration in both, but there was only partial restoration in one case out of the six non-operated cases of the lower extremity, and in

that case the embolus was lodged in the posterior tibial, where the rich collateral circulation around the knee-joint was probably sufficient to maintain the circulation of the leg. It is definitely shown from these comparative figures that, the time element being the same, better operative results are obtained in the vessels of the upper extremity than in those of the lower. May this difference be explained by the establishment of collateral circulation?

Following up some of the arteriotomy operations of the vessels of the upper extremity, we find that in one of the patients operated on for a subclavian embolus, no radial pulsation and no blood-pressure reading could be obtained on that side six months after operation. In the case of an embolus of the radial artery operated on several days later, a similar condition existed long after the operation. In two cases of axillary embolectomy followed by complete circulatory restoration, there was no radial pulsation in the radial artery, ten days and two months after operation. In the brachial arteries we find in one case (IX) that circulatory restoration was not complete immediately after the operation since there developed gangrene of the thumb, necessitating amputation. In another case there was gangrene of thumb and index finger, followed by slow improvement and restoration of circulation to the remaining fingers and forearm (Case XLI). In a third case (LV) the follow-up shows patient well one year later. In the fourth case patient showed evidence of muscular atrophy and marked weakness of forearm two months after operation but no gangrene (Case LXXIV). There was no radial pulse left in three of these cases several months after the operation. These four cases were operated on between one and six hours. Lack of radial pulsation is recorded in two other cases of brachial embolectomies where the circulatory restoration was complete, although patients died a week or several days later from emboli in other vessels. All three cases in which the time element was not stated were successful. It is interesting to note that in one case no arterial sutures were used to close up the incision. Bleeding was stopped by hot sponges. It is not likely that circulation in the brachial artery was restored since the arteriotomy opening must have been closed by a clot formation and whatever circulation remained, was probably carried on through the collateral branches. In another case there was no radial pulse felt at any time after the operation, in spite of the fact that circulation was definitely restored. Of the two non-operated cases, one was a female, seventy-two years old—cardiac. All symptoms of embolic obstruction of the brachial artery were present. This was followed by an ischæmic contracture and beginning gangrene, which completely disappeared within two months. The muscular contraction remained. Patient died two months later from hemiplegia. In the second case death occurred three days later from a cerebral embolus, but there was no apparent difference in the two arms and no evidence of gangrene despite the fact that there was no radial pulsation. Collateral circulation must have been established.

*(To be continued)*

## SURGICAL DISEASES OF THE SHOULDER BURSAE \*

By JAMES MORLEY HITZROT, M D

of New York, N Y

AMONG the conditions which produce disabilities in the shoulder the bursae about the shoulder-joint play an important part

The bursae about the shoulder-joint are the subdeltoid with its prolongation beneath the acromion, the bursa over the coracoclavicular ligaments, the bursa beneath the subscapularis and the bursa beneath the coracobrachialis and the shorthead of the biceps. Of these the subdeltoid bursa is the most important. This bursa is intimately connected with the freedom of motion in the shoulder-joint and is closely adherent over the capsule of the joint but in none of the operations I have done upon it, or in none of the dissections after distention of this bursa have I been able to demonstrate any communication with the shoulder-joint. Like all serous cavities, especially the joints, it is lined by a layer of endothelium on a loose areolar structure with a denser outer coat composed of fibrous tissue of greater or lesser density in varying locations, and like all joint cavities it is subject to varying conditions which bring about changes in the bursae walls.

By far the most common cause of disease in this bursa is injury. This bursa is involved in injuries to the acromioclavicular joint, dislocations of the shoulder, fractures of the head, neck, and tuberosities of the humerus, injuries to the supraspinatus and infraspinatus tendons; and to certain less easily determined injuries produced by overuse of the arm, wrenches and twists of the shoulder-joint and by minor blows upon the shoulder region or by falls upon the arm or hand.

With all of these injuries involvement of the bursa is common. This may be the result of direct tearing of the bursal wall with hæmorrhage into the bursa, as in fractures, or an exudative reaction with distention of the bursa by fluid, in acromioclavicular injuries and dislocations, or it may be a milder reaction with only a little exudate but with congestion and adhesion between the bursal layers with some erosion or desquamation of the endothelium, but in all cases with a loss of freedom of motion and cohesion between the synovial surfaces. The later changes produce an adhesive bursitis with finer or denser adhesions within the bursa, hypertrophy of the synovial folds with a villous synovitis, fatty degeneration of these villi and many changes of varying intensity and degree throughout the component portion of the bursa. All these pathological changes go to produce a loss of motion in the joint, produce pain and have been described under the general heading of stiff and painful shoulder.

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\* Read before the New York Surgical Society, January 11, 1933

Codman, whose communications upon the subject of traumatic subdeltoid bursitis are classical, considers injury to the tendon of the supraspinatus—that is, tears of varying degrees—as the most common cause of inflammatory changes in the bursa

Codman and Wright studied the “calcified deposits” in the supraspinatus tendon and considered them to have been the result of minor injuries to the tendons with subsequent tissue changes and the deposition of calcium salts

Wilson (J A M A, vol xcvi, p 453, February 7, 1931) considers rupture of the supraspinatus tendon a common injury and in common with other surgeons he has been overlooking this injury and reports a group of complete tears of the supraspinatus tendons and discusses in detail the symptoms and treatment of this condition

Brickner (Am Jour Med Sci, No 3, vol cxix, March, 1915), states that these calcareous deposits are in the tendons beneath the floor of the bursa, they are circumscribed in their location near the insertion of the tendon but are not enclosed in a sac The material is composed of calcium oxalate and carbonate, and smaller amounts of magnesium carbonate, and may occur rapidly after the injury as determined by the X-ray He con-

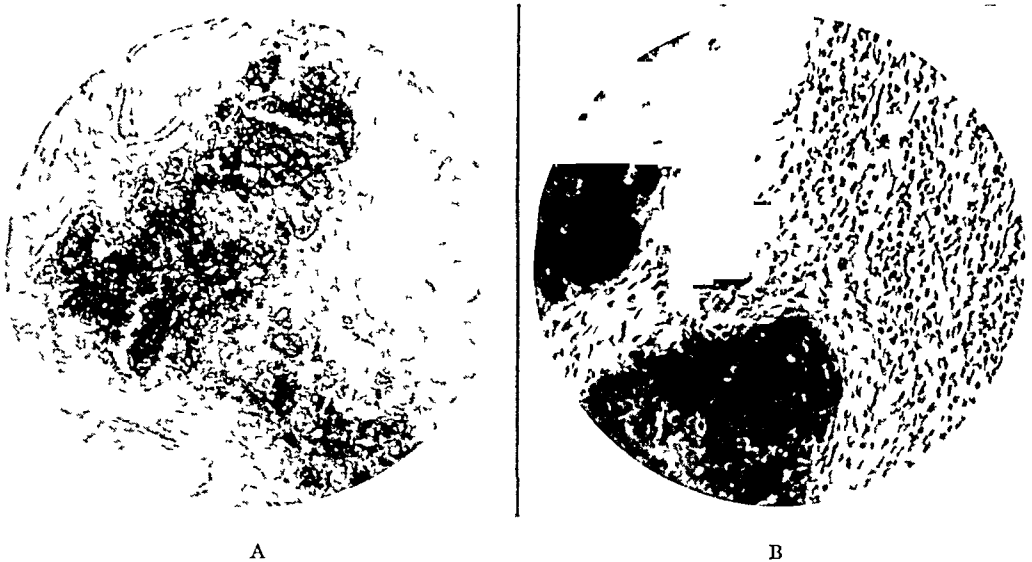


FIG 1 A—Sections through areas of calcification in the supraspinatus tendons which shows cells with the character of immature or altered cartilage cells Those toward VII o'clock in B look very much like cartilage under the high power

siders them the result of repeated traumata by pressure of the tendon against the acromion process and the deposition of lime in the poorly vascularized tissue

Kolliker (Human Histology, London, Sydenham Society, 1853, vol 1, p 251) describes cartilage cells in the Achilles tendon at its attachment into the os calcis Because of this finding and from one of my cases (Figs 1a and 1b) I suggest that the calcification in some of these cases may be due to changes in cartilage cells present in the tendon at its attachment to the bone as a result of the injury to these cells with the subsequent change in the cartilage and calcareous changes subsequent to these injuries In many areas under the microscope the cells resemble very closely immature cartilage cells in various stages of disintegration and calcification

Moschcowitz (Amer Jour Med Sci, No I vol cl, p 115, July, 1915), who studied the histopathology of the material removed by Brickner, considers these changes as a result of tendonitis with necrosis, hyaline degeneration and calcification, and discusses fully the changes seen in the cases he studied and gives an ample discussion of the subject in his paper

Dollinger (Zentralb f Chir, vol lix, p 579) states that the chief cause of painful shoulder is not due to the bursae but to inflammatory infiltration of the supraspinatus

with "Muskelharte" of this muscle due to the overstretching of this muscle causing tearing of the muscle bundles and pain from this cause. If I interpret his communication correctly he believes that bursal inflammations about the shoulder are rare and that the present importance laid to bursal inflammations is erroneous.

A S Taylor (Med News June 3 1905) expresses the belief that in disabilities in the shoulder following a fall upon the shoulder the essential lesion is a palsy produced by overstretching of the brachial plexus, while in those following a fall upon the outstretched hand the plexus is similarly injured by pressure between the clavicle and the first rib.



FIG 2—Deposit in tendon, culture *Streptococcus hemolyticus*. Culture from root abscess about molar tooth contained same organism. Operation on bursa, extraction of tooth, complete cure.

In a contribution to the subject of Painful Shoulder (Minnesota Med, pp 148-150, March, 1928) I reported three cases of exudate on the calcareous variety in the supraspinatus tendon in which a hæmolytic streptococcus originating from a tooth in one case, a sinus in another and a hæmolytic aureus originating in an ulceration of the cervix caused an adhesive bursitis of the subdeltoid bursa (Fig 2).

H Gunther (Deutsche Med Wchnsch, vol lvii, p 1362, August 31) calls attention to the rheumatic involvement of the bursa and tendon sheaths and states that involvement of the subdeltoid bursa with shoulder disabilities is not uncommon in acute rheumatic conditions. In his article he refers to the older writers, Bell and Cloquet, and Fournier.



who considered involvement of the bursa as most commonly of gonorrhœal or syphilitic origin

One case in my series illustrates very beautifully the involvement of the subdeltoid bursa with the formation of rice bodies in a case of chronic joint rheumatism Mrs G, aged thirty-eight years, was referred to me in March, 1930, by Dr L A Wing for a swelling in the left shoulder region About six months before I saw her she began to have pain in the left shoulder region radiating down the left arm About the same time she noticed a swelling in the left shoulder on the anterior aspect which has gradually grown larger She has never noticed any sudden increase in size and there has been no local fever The pain at first was severe but more recently has grown to be a dull ache which is aggravated by use Her arm has also gradually become more stiff and she has been unable to move it sufficiently to get it over her head At sixteen, twenty-two years ago, she had an acute attack of polyarticular rheumatism with fever, sweats, *etc*, which

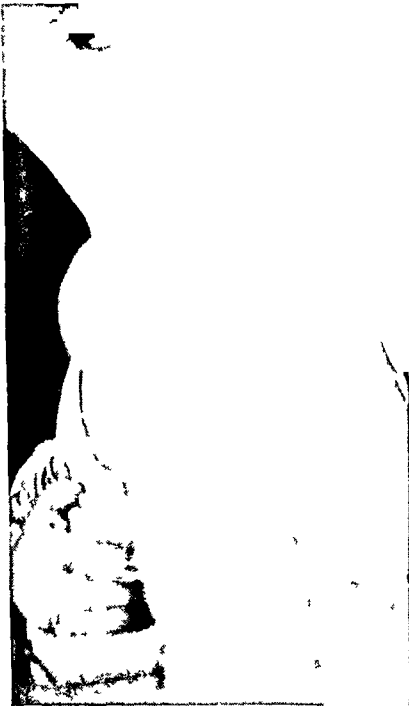


FIG 3



FIG 4

FIG 3—Bursitis of left subdeltoid bursa (See case report page 4 and Figs 4, 5 and 6)

FIG 4—Photograph of bursa Opened with extruded rice bodies (Same as Fig 3)

left both elbows, wrists, knees, and ankles crippled Since then she has had recurring attacks of joint pain at varying intervals relieved by salicylates For the past five or six months she has had pain in the back and neck which was most severe when the shoulder began, but which is now less intense and troublesome only from time to time Her remaining history except for the birth of two children is unessential (Figs 3, 4, 5 and 6)

When I saw her there was a large swelling in the left shoulder region with grating in the shoulder-joint and marked limitation of motion in all directions This swelling occupying the region of the subdeltoid bursa was tense, seemed fluctuant in character and contained movable bodies which could be more or less definitely defined Both elbows and wrists were swollen with considerable peri-articular thickening and limitation of motion Both knees and ankles were also swollen and showed essentially the same changes as in the elbows and wrists X-ray pictures showed a diffuse arthritis of all the involved joints of the hypertrophic variety The shadow in the left shoulder was not connected

## SHOULDER BURSAE

with the bone. Her tonsils had been removed. The teeth were in good condition. Her heart sounds were normal.

She was operated upon April 2, 1930 under the diagnosis of chronic hypertrophic bursitis of the left subdeltoid bursa, through an anterior incision through the fibres of the deltoid muscle. A part of the attachment of the deltoid to the acromion was divided, removing a portion of the bone in order to expose the bursa. This was large and thick-walled. It was dissected out without difficulty until the upper portion beneath the acromion was reached when it was kicked and a large number of rice bodies escaped (Fig 4). Except for this difficulty the bursa came free from the supraspinatus without great difficulty. There was no communication with the shoulder-joint and the bursa was dissected free in this area with surprisingly little difficulty. The wound was packed with hot saline packs to control the oozing and closed by suturing the acromion process to reattach the deltoid and by closing the divided deltoid muscle. A twisted silk worm drain was placed at the lower angle to take care of the exudate. She made an uneventful recovery and was discharged from the hospital on the fourteenth day with the wound healed.

At first there was limitation of motion at the shoulder with tenderness over the greater tuberosity which disappeared with appropriate physiotherapy and graded exercises. Seven months after the operation movements in the shoulder were complete and painless in all

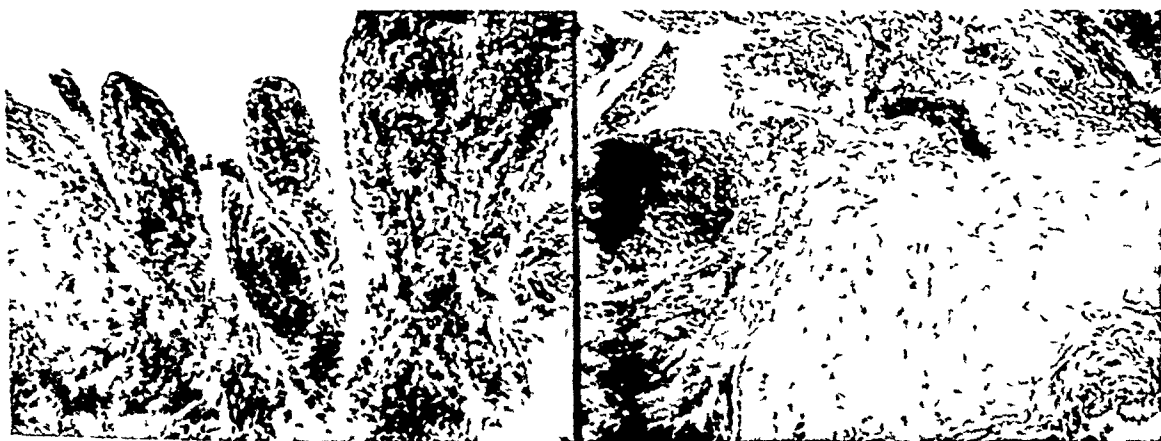


FIG 5

FIG 6

FIG 5—Showing villous hypertrophy of bursal wall with hyaline degeneration of cells preceding the formation of the rice bodies

FIG 6—A section of the bursal wall showing tendon at A and the bursal wall at B with calcareous deposit at C

directions. Because of her arthritic pains elsewhere she was referred to Doctor Shuster, who reported that her arthritic condition was due to a nonhaemolytic streptococcus of tonsillar origin. She was treated by him with a vaccine prepared from this strain and on November 11, 1932, he reported her as completely free from arthritic pains for one year.

The pathological report by Doctors Smith and Olcott follows

Chronic bursitis (subdeltoid) with rice-body formation. Twelve paraffin sections from various parts of the capsule show evidence of a profuse chronic inflammatory process. There are innumerable villous processes covered by a layer of rather flattened cells which are difficult to identify as mesothelial in origin. Each villous stalk has a very profuse capillary blood supply and a fibrous tissue stroma. In the areas where the rice bodies are forming, hyaline degeneration of these villi can be made out, with obliteration of the vessels, and a concomitant mononuclear response. No definite histological evidence of tuberculosis can be made out, although a few atypical areas of monocytic hyperplasia are difficult to absolutely exclude as possibly tuberculous in origin. (Doctor Smith)

Deltoid bursitis, rice bodies. Specimen is received in two bottles. In one there is a sac which has been opened up but seems to have been about 6 by 5 by 3.5 centimetres in size. It is composed of injected membrane around 0.2 centimetre in thickness. The

outer surface is smoothly white, the inner one contains several thickened papillary areas and some of these resemble rice bodies, while being still attached to the lining. Many loose rice bodies are found. In the other jar there is a little similar tissue which contains some hard areas and at least 100 rice-like bodies. Frozen section shows one of the rice bodies to consist of fibrin in concentric layers. On the inner lining of the bursa there are several projections which consist largely of ovoid cells and also contain many lymphocytes. There is no evidence of tuberculosis. The wall of the cystic areas is made up of connective tissue. (Doctor Olcott)

Cultures made from the bursa, from macerated portions of the bursal wall and from macerated rice bodies, were sterile.

In many cases the history of injury or of infection is absent. In women I have been asked frequently if driving a closed car with the window open could explain the difficulty with the shoulder. As the lesion is in the left shoulder, this being the shoulder exposed to the wind, the coincidence if nothing else is striking.

In other cases Brickner suggests some undetermined metabolic process as the possible cause.

Naturally, with so many different causes, the symptoms of bursal involvement are variable both in the character and extent of the symptoms. Probably the best way to consider them is as acute, subacute and chronic cases in order to get a perspective of the method of onset. The separation into these varieties is subject to many modifications, since an acute case may become chronic and a chronic case become acute, *etc*.

In the acute cases whatever their cause the onset is sudden. The pain is agonizing and completely disabling. It is located in the shoulder region over the deltoid and may radiate down the arm to the fingers and up the neck. Any movement of the arm causes excruciating pain and this pain is out of all proportion to the findings on examination. Swelling in the involved area is rare. Pressure over the region of the greater tuberosity is common and exquisite tenderness in this region is significant. Dawbarn's sign has not been of value as it is impossible to move the arm sufficiently to cause the tender point to disappear beneath the acromion.

Examination of skin sensation is indefinite, there may be areas of hyperaesthesia over the distribution of the circumflex nerve and in the distribution of the branches of the posterior cord down the arm but these examinations have proven too conflicting and the distribution of the areas too variable to make them of any value in my experience. In a real neuritis these sensory changes are more constant and more definite in their distributions.

Atrophy of the deltoid and the supraspinatus muscles occurs rapidly, the shoulder becomes flattened and the head of the humerus prominent. An X-ray picture is of aid in determining the presence of calcareous deposits in the tendon but does not exclude inflammations of the bursa.

In the subacute cases the onset is more gradual usually with some slight preceding pain and disability which becomes more acute until the shoulder becomes completely disabled and any motion is avoided because of the pain.

## SHOULDER BURSAE

The conditions described in the acute cases occur but are less rapid and less severe

In the chronic cases the symptoms are variable, pain is present after use never particularly severe but as a rule sufficient to be annoying and the patient notices a gradual stiffening and loss of motion in the joint. After use this pain is worse and may be located in the scapular muscles especially if the range of shoulder-joint motion has been interfered with. Examination will show a moderate amount of atrophy of the shoulder muscles, some tenderness over the region of the head of the humerus but the most marked findings are



FIG 7—Fracture of greater tuberosity by fall on shoulder in man of twenty eight. Calcareous deposit in supraspinatus tendon, hemorrhage into bursa, operation, complete range of shoulder motion

the restricted motion in all directions at the shoulder on both active and passive movements. This restriction may be slight or it may be a complete loss of motion in the shoulder-joint.

Many of the acute and subacute forms become chronic in the manifestations and many of the chronic types may have exacerbations which make them resemble the other types. In fact, so many variations exist that sharp lines of demarcation are often impossible.

In the treatment of a condition produced by such a variety of causes there must be a varied one to meet the conditions. When the condition is obvious

as in fractures or dislocations the treatment of that condition should follow orthodox lines

In the various injuries involving fractures of the tuberosity, tears of the supraspinatus tendon, operation is indicated with necessary steps to repair the injured area. The early removal of the blood and exudate from the bursa helps materially in decreasing the period of disability (Fig 7)

In the cases less obvious to their cause, the acute and subacute types are best treated by rest in bed, sedatives, especially morphine in the very acute types, and hot moist applications locally

In my experience dry heat, diathermy and massage increase the pain without resulting benefit during the acute stage. After the more acute symptoms have subsided, which occurs in from three to seven to ten days, dry heat, diathermy, graded exercises, massage and the gradual abduction method advocated by Brickner are indicated. The treatment in each case should be adapted to the case in question

When the cases show large deposits in the X-ray in the attachment of the supraspinatus, or in recurring attacks with persistent or increasing deposits, operation with the removal of these deposits is indicated as it gives the most rapid relief, is curative in most cases, and the rapid return of function and the freedom from recurring attacks is striking

When the acute symptoms have subsided and stiffness of the shoulder persists, manipulation of the shoulder under an anæsthetic is indicated. During these manipulations adhesions can be felt to break and motion increases in freedom as the manipulation proceeds. Caution should be exercised in these manipulations not to use too strenuous efforts to free the joint as fracture of the humerus may result

After manipulation the arm should be kept in the abducted externally rotated position either by suspension in bed or in a plaster splint until the acute reaction and pain following the manipulation have subsided and then treated by physiotherapy, and graded exercises to restore motion

In cases with coincident arthritis of the shoulder-joint the cases for manipulation should be selected with great care and the prognosis for a satisfactory outcome should be guarded

Tuberculosis of the subdeltoid bursa occurs only in conjunction with underlying tuberculosis in the bone especially in the greater tuberosity, or by extension from the head of the bone. In the first instance early radical excision of the bone focus together with the bursa is indicated. The operation is difficult and the result leaves much to be desired. The condition is rare. I have seen but one case. Brickner (*Amer Jour Med Sci*, vol clix, p 351, March, 1915) had seen only one case and gives one case described by Belhant. In tuberculosis of the head of the bone and shoulder-joint the symptoms and treatment are those of that condition except that involvement of the bursa requires its excision

Tumors of the bursa are rare. I have seen no primary tumors of the bursa about the shoulder-joint

## SHOULDER BURSAE

Subcoracoid bursitis is very rare. The bursa is situated below the coracoid, beneath the tendon of the coracobrachialis muscle. In this lesion tenderness occurs over the coracoid process or just below it, pain occurs when the arm is abducted and there is inability to hold the arm up in the abducted position because of the pain. There is also pain in drawing the arm forward and upward as in putting on a coat sleeve, carrying any weight, and pulling down upon the arm causes pain in or near the coracoid process. The diagnosis is difficult and as cases with the above symptoms subside with support



FIG. 8—Calcification in bursa over coracoclavicular ligaments. Man (fifty-two) fell on shoulder six months previous. At operation calcified body in a sac (bursa?) over coracoclavicular ligaments. (See text, page 9.)

of the arm and heat, the diagnosis can only be probable rather than proven in suspected cases.

Involvement of the bursa over the coracoclavicular ligaments is also rare. I have seen two recognizable cases. In one a man with an acute mastoid following pneumonia which I saw with Dr. J. P. Erskine three weeks after operation for the mastoid, an acute swelling appeared just below the clavicle and above the coracoid which was opened and found to be a suppurating bursa which contained pus which on culture yielded a streptococcus.

The second case was a laborer aged fifty-two years, who six months before I saw him had fallen on the left shoulder. The shoulder was said to have been swollen and there was tenderness over the acromioclavicular joint. When I saw him there was distinct

limitation of motion in the shoulder-joint, especially in rotation, but both active and passive motions were painless. Carrying weight and pulling with the arm caused him pain which he located in the region of the coracoid process and in the acromioclavicular region. Just below the clavicle the coracoid process seemed large and there was deep tenderness there. There was also some thickening over the acromioclavicular joint and a curious crepitation in the two above regions in motions of the shoulder-joint.

The X-ray picture (Fig 8) showed an arthritis of the shoulder and acromioclavicular region and a curious shadow above the coracoid process which we interpreted as a fracture of that process due to a probable separation of the bone caused by the separation of the ligaments from the coracoid. As he did not improve he was operated upon December 22, 1913, by an incision parallel to and below the clavicle, exposing a curious mass which proved to be a sac containing a calcified body attached by a pedicle to the thick-walled sac which was dissected out with some difficulty. Unfortunately, the specimen, except the calcified body with its pedicle, was lost so that a pathological report is not obtainable. The coracoid process and the ligament were, however, not involved and from its character and location I believe it to have been a bursa with the changes in the wall, villous hypertrophy and calcification of a villous as evidenced by the pedunculated calcified body. Just what relation his injury bore to the pathological process found is problematical and the case is unique in my experience.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 11, 1933

The President, DR JOHN DOUGLAS, in the Chair

### APATHETIC HYPERTHYROIDISM

DR PERCY KLINGENSTEIN presented an elderly woman, probably seventy years of age, whom he saw for the first time in June, 1932. Her history dated back three years, at which time she began to complain of the following series of symptoms. A dry feeling in her mouth and over her tongue. The condition was not annoying and did not cause any distress, this was not constant but of an intermittent character. There was no associated or neurological symptoms. There were no dermatological manifestations or gastrointestinal manifestations at any time during the present illness. Three weeks ago the tongue became very dry and fissured, with no concomitant bleeding but with pain which has become much more severe during this time. No medication was given or advised and on the advice of her physician she came to the hospital for study. No history of psychic trauma. For the past two years she has been conscious of palpitation when disturbed. No history of excessive perspiration except for two or three severe night sweats during this past winter. No tremor, exophthalmos, hoarseness, or difficulty in breathing, but a sense of increased weakness, loss of nineteen pounds in weight, an increase of appetite, and increased irritability. The tongue showed evidences of atrophy of the papillae. There was no thyroid enlargement, no exophthalmos, no significant tremor. Cardiac status was normal for a woman of her age, her blood-pressure was 154/76. Because of the excessive loss of weight, weakness and some palpitation, in spite of no outward or discernible evidences such as are usually associated with Graves' disease, Graves' was suspected, for the treatment of which she entered the hospital.

Basal metabolism upon admission ranged between plus 52 per cent and plus 36 per cent. She was placed upon small doses of iodine. The second admission just recently, for exacerbations of her previous symptoms, showed at that time basal metabolic readings of plus 47 per cent to plus 28 per cent on discharge.

The reporter called attention to a clinical type of hyperthyroidism recently described by Lahey, in which particularly in the aged the striking signs of hyperthyroidism are lacking. This condition occurs almost exclusively in the elderly and should be suspected in any elderly patient with persistent weight loss and persistent pulse elevation. He also calls attention to the different type of post-operative reaction which these patients may manifest after surgical attack upon the thyroid gland, in which case instead of presenting the features commonly associated in a post-operative thyroid toxicosis or storm, such as delirium and restlessness, these patients sink into an apathetic comatose state.



DR EMIL GOETSCH said that it seemed unnecessary to him to designate these cases by the term "apathetic," because the apathy is only a symptom of the general syndrome which ends with a worn-out gland and a worn-out patient. The symptoms in these patients are not unlike hyperthyroidism in other respects. He therefore wondered why a separate classification was made. These cases respond to treatment in the same way as any other type of Graves' disease. However, one may not appreciate the degree of hyperthyroidism because of the absence of external activity. The basal metabolic rate of plus 52 is quite high, higher than one would anticipate after hearing the history and examination of the patient. Knowledge of the basal metabolic rate is exceedingly important in these cases to prevent untoward results after thyroidectomy.

DR WILLIAM BARCLAY PARSONS said that he agreed with Doctor Goetsch in that it was hardly worth while to have a separate classification for these cases, but one must be on one's guard not to miss cases in which the activation of the general nervous system is absent. One does not separately classify cases of duodenal ulcer or of appendicitis that do not present all the text-book symptoms, and the difficulty in diagnosing instances of these diseases where typical symptoms are absent has been commented on numerous times. In nearly all cases of hyperthyroidism there is emphasis on the symptoms from one or more of the systems involved, and there may be absence of symptoms in the gastro-intestinal, cardiac, muscular, as well as in the nervous system. It is, however, of real importance to evaluate the patient's risk before beginning preparation with iodine, in order not to be misled by an apparently good risk on the day of operation.

DR RICHARD LEWISOHN felt that the great importance of Lahey's observation of apathetic hyperthyroidism was based on the fact that these cases may show serious post-operative complications without offering any of the pre-operative danger signals (nervousness, rapid pulse, and other symptoms). Unless the surgeon recognizes this clinical picture, he may be misled into doing too much surgery (one-stage operation instead of two-stage operation) to the detriment of the patient.

#### FREE FASCIA LATA TRANSPLANT TO COVER DEFECT IN ABDOMINAL WALL

DR PERCY KLINGENSTEIN presented a woman, twenty-eight years of age, who was admitted to Doctor Lewisohn's service at Mt. Sinai Hospital about seven months previously with a firm, irregular, non-tender tumor mass in the left epigastric region about the size of a lemon. It moved synchronously with movements of the abdominal wall and became more prominent when the abdominal musculature was tensed. A pre-operative diagnosis of a desmoid (fibrosarcoma) was made. Under general anæsthesia the tumor was exposed, the rectus sheath was adherent to it broadly. The fascia was then incised widely around the presenting mass. Further dissection revealed the tumor had infiltrated the muscle and was adherent to the underlying transversalis fascia. Therefore a portion of the left rectus muscle and the underlying

## SUBTOTAL GASTRECTOMY FOR DUODENAL ULCER

peritoneum were excised to permit removal of the tumor. The dissection was carried into the linea alba medially. The peritoneum and transversalis fascia were then sewn over in a transverse fashion with chromic gut without undue tension. Medially, chromic gut was used to unite the fascia in the region of the mid-line. Upon the large central fascial and muscle defect, about six by eight centimetres in size, a free fascia lata transplant was applied, which was taken from a previously prepared thigh. This was first anchored by a few chromic gut sutures at strategic points and subsequently made adherent by a continuous suture of fine chromic gut. The strip of fascia was perforated in numerous places to permit serum to escape in the resulting dead spaces. Closure of wound without drainage.

Pathological report was a fibrosarcoma. Macro-specimen consisted of a mass of tissue measuring seven by four by two centimetres. Upon section, the central portion consisted of a circumscribed but not encapsulated mass of firm fibrous tissue. Its anterior surface was covered by fascia, posteriorly by peritoneum.

The patient's wound healed *per primam*. It is now eight months since the operation without evidences of a hernia. The reporter presented the patient as a case in which the use of a free fascial graft has permitted a wide excision of a tumor without the formation of a subsequent hernia in spite of the large sacrifice of a portion of the entire abdominal wall.

DR ALEXIS V MOSHCOWITZ stated that, as a general rule, he is not in favor of fascial transplantations for the cure of hernia. However, he fully agreed with the views of Doctor Klingenstein that it was absolutely indicated in the case presented by him. Unless something of the kind was done, there was nothing but skin to cover the huge defect caused by the excision of the desmoid. This case is important from another viewpoint. It again proves that the physiological function of muscle is motion and not, as is occasionally ascribed to it, protection. Doctor Moshcowitz is so convinced of the correctness of this view that for a great many years he has abandoned all muscle sutures for the radical cure of any hernia.

## SUBTOTAL GASTRECTOMY FOR DUODENAL ULCER

DOCTOR KLINGENSTEIN presented a man, sixty-four years of age, who was admitted to Doctor Lewisohn's service at Mt Sinai Hospital, with a history that dated back nine years, beginning with an episode of right upper quadrant pain which radiated to the right lower axilla and right shoulder. This pain was accompanied by a temperature of  $103^{\circ}$ , and chills. There was no jaundice. Three years later there was a recurrence of these symptoms, which lasted about two weeks. Another free interval existed until three months before admission, since which he has had almost daily attacks of right upper quadrant pain, radiating across the epigastrium and to the right shoulder and scapula. In the past two years he also has often had upper abdominal pain, cramplike in nature, two or three hours after eating. Some loss of weight. He was somewhat emaciated with some resistance to palpation in the right upper quadrant of the abdomen, with tenderness in this area just under the costal margin. No tumor masses felt. With the exception of some clubbing of the fingers and a few scattered râles upon auscultation of the chest, the physical examination was otherwise negative.

Under the assumption that the patient was suffering from a chronic cholecystitis and cholelithiasis, X-ray of the gall-bladder was done. This

showed the gall-bladder to fill and empty with dye, but a personal communication from the radiologist that there was probably a diseased gall-bladder, along with the clinical picture, resulted in an operation, with a pre-operative diagnosis of cholecystitis

At operation, which was done under spinal anæsthesia, supplemented by gas-oxygen and ether inhalation anæsthesia, the upper abdomen was explored through a right paramedian incision. The gall-bladder was found normal. Palpation of the stomach and duodenal region revealed a large penetrating ulcer on the superior and anterior aspect of the first and second portions of the duodenum, with a number of perigastric and periduodenal adhesions. In spite of the large size of the ulcer, it was freely mobile and was practically non-adherent to the pancreas. For this reason resection of the ulcerated area and the antrum of the stomach was decided upon. This was done in the usual manner, securing the cardinal vessels of the stomach, cutting the stomach across between clamps, reflecting back its distal portion, completing the duodenectomy. The duodenum was easily closed. Gastrojejunostomy of end-to-side type, after closing the upper angle of the stomach, was carried out. Wound was closed in layers without drainage. The specimen consisted of a portion of resected stomach measuring sixteen centimetres on the lesser curvature and twenty on the greater. At the distal portion of the stomach there is an area of induration on the inferior surface of the greater curvature saddling it. There were no lymph-nodes found. Straddling the greater curvature about five centimetres from the pyloric ring is a deep ulcer surrounded by raised indurated borders which overhang the distal portion. The base of the ulcer is reddish-gray in appearance and does not show a bleeding point. The ulcer measured along its greatest diameter two by five centimetres. It is thickened and has a coarsely granular appearance.

The patient made an entirely smooth and satisfactory post-operative recovery. He was discharged well, nineteen days after operation.

DR FREDERIC W BANCROFT said that one might assume that hyperacidity in duodenal ulcer is the result and not the cause of the disease. Recent studies in gastric physiology show that during the latter part of digestion bile and duodenal contents are regurgitated into the stomach, thereby reducing the total acidity. When ulcer occurs there is a scar-tissue formation just distal to the pyloric ring and associated with this is pyloric spasm. This will of itself tend to prevent the regurgitation of the alkaline substances, and therefore there will be increased gastric hyperacidity. If the assumption is that hyperacidity is the result of the scar and not the cause the operation of choice should be designed not to remove the greater part of the acid-forming cells but to allow rapid dumping of gastric contents and a satisfactory stoma to allow reflux of duodenal contents into the stomach. For the above reasons he believes that Doctor Klingenstein's procedure in the case reported was well selected, as a resection and retrocolic Polya anastomosis allows the rapid dumping of gastric contents and is well suited to allow the reflux of bile and duodenal contents.

#### FRACTURE NECK OF THE HUMERUS

DR RICHARD LEWISOHN presented a girl who had been admitted to Mt Sinai Hospital October 11, 1928. She was then three years old. She had fallen down one flight from a fire-escape to the street. There was marked

limitation of motion in the right shoulder. Rontgenographical examination showed a complete transverse fracture through the humerus in the region of the surgical neck with over-riding of the fragments. The lower fragment was displaced mesially. An immediate attempt at closed reduction under X-ray control was unsuccessful. X-ray examination taken the following day showed the same findings as noted above.

An open operation was performed October 15. A three-inch elliptical incision was made over the right shoulder. The lower fragment was displaced upward, forward and inward. The capsule had to be incised in order to expose the fragments properly. The fragments were approximated, a nail was hammered into the head of the humerus from below and the fragments were thus locked together. The capsule was closed by interrupted chromic stitches, the muscles were brought together with plain catgut and a few interrupted stitches of chromic catgut were put into the skin. The arm was placed into an aeroplane splint. An X-ray examination taken the following day showed the fracture of the humerus to be now reduced, the fragments being in perfect position and alignment with the nail *in situ*. The patient was discharged October 24, but re-admitted November 28 for removal of the plaster splint. A rontgenogram taken on the day of admission showed the same perfect apposition of the fragments, the nail being in the same position as noted above. The plaster splint was removed and passive motion was started. A picture taken two days later showed that the nail had rotated completely, so that its head, which had formerly been distally, now lay proximally in relation to the shoulder-joint, and its



FIG 1.—Fracture of the surgical neck of the humerus with marked displacement

point was directed towards the soft tissues of the shoulder. Evidently some rarefaction of the bone had taken place around the nail which was thus hanging loosely in the bone. When passive motion was instituted, the nail dropped out of the bone. The nail could not be felt by palpation. It was removed under X-ray control December 10 through an incision made through skin and muscles. The nail was situated partly subperiostally.

The post-operative course was disturbed by a subdeltoid infection, causing a high temperature from December 15 until January 5, and requiring a number of incisions. However, as the infection was periarticular, not intra-articular, motion in the shoulder-joint was not limited. X-ray examination (December 28, 1928) showed that the proper alignment of the fractured ends had been disturbed and the head had again slipped laterally. There was evidence of considerable callus formation. The girl was discharged from the

hospital February 11, 1929 She has been seen at frequent intervals in the return clinic The functional result is perfect The right arm has grown normally since the operation An X-ray film taken recently shows perfect alignment

DR CARL G BURDICK said he thought it was unusual for a surgeon to feel that these fractures in children should have open reduction Any one who has followed up the results of fractures in children for years, where there has been a considerable amount of displacement, has been continually surprised with the wonderful results At Bellevue Hospital they have followed from 150 to 200 of these cases with poor anatomical reduction and practically all of them in a few years have had perfect anatomical alignment and function

Doctor Burdick presented the slides of a child ten years old that had a fracture of the surgical neck of the humerus with mesial displacement and two inches' overriding The patient was seen five weeks after the injury On looking at the X-rays all the members of the staff agreed that an open reduction was indicated, but on examination function was only slightly limited and it was decided to keep the child under observation At the end of four months the X-ray revealed a practically normal bone with very little indication of the previous fracture

DR JOHN DOUGLAS endorsed Doctor Burdick's remarks as to the non-necessity for operation in these fracture cases in children This was illustrated by a case the speaker had shown some years ago before this society It was that of a fracture of the lower end of the femur with bad displacement No traction could be made because of the amount of abrasions and dirt and sand ground into the skin Reduction under anæsthesia was unsuccessful and therefore it was left alone There was improvement in a few months and in six months it was almost impossible to tell which leg had been fractured

#### ACUTE OSTEOMYELITIS OF THE HEAD OF THE FIBULA

DR RICHARD LEWISOHN presented a boy who was admitted to Mt Sinai Hospital April 19, 1928 He was then three years old After a sore throat for one week, the mother noticed that the child limped, the temperature was elevated to  $106^{\circ}$  The child was very restless during the night When admitted he was an extremely septic child Temperature  $105^{\circ}$  There was marked tenderness over the head of the right fibula Blood culture showed hemolytic streptococcus *Diagnosis*—Osteomyelitis of fibula with sepsis

April 20 a three-inch longitudinal incision was made over the head of the right fibula The peroneal nerve was exposed and held away by a retractor A subperiosteal abscess was incised and an osteotomy was performed The head of the fibula contained a small amount of pus The wound was packed with iodoform gauze When the leg was lifted up for application of the bandage, a drop foot was noted Appreciating the significance of this finding, the wound was reopened and carefully inspected It was found that the peroneal nerve had been severed Evidently the nerve had slipped out from under the retractor and had been cut, when the incision was lengthened for

## CHOLELITHIASIS

the osteotomy of the fibula. The ends of the nerve were sewn together with fine arterial suture material and the wound was redressed.

The high temperature persisted. Two abscesses developed, a subpectoral abscess and a subperiosteal abscess of the left forearm. Both were incised April 28. Following this the temperature subsided. The blood culture was reported negative April 29.

During the next two weeks the patient's temperature ran a moderately febrile course. May 15 the temperature rose again to  $104^{\circ}$ . A pyarthrosis of the right knee-joint had developed. The joint was opened by two lateral incisions and pus was evacuated. The pus contained hemolytic streptococcus. The wound healed well during the next few weeks. The Willems treatment was employed. The temperature was normal about one week after this operation. Electric reactions showed a degeneration in the nerve supplying the extensor longus digitorum and peroneal muscles.

The boy was discharged from the hospital June 26, 1928. Recent re-examination (December 29, 1932) shows perfect function of the knee-joint and foot.

DR FENWICK BEEKMAN remarked upon the rapid return of function following the cutting of the peroneal nerve. Several years ago he presented before this society a boy on whom he had done a plastic operation in the axilla for scar contraction. During this procedure the musculospiral nerve was cut but was immediately sutured. In time there was complete return of the function of the nerve. In another case of a baby born with a huge hydroma of the head he had accidentally cut across a branch of the facial nerve. The child now has full function, complete recovery having occurred in thirteen months. Where nerve suture has occurred in children the nerve function comes back more readily than it does in adults. Regarding the pyarthrosis in a number of cases of suppurative arthritis of the knee at Bellevue there was a lesion in either the epiphysis or metaphysis and in all of them results were completely satisfactory by merely draining the joint and not touching the bone. When the tension is relieved the lesion in the metaphysis or the epiphysis is relieved. In one case, however, where the patient became extremely septic, the leg was amputated and on dissection primary osteomyelitis of the epiphysis of the femur was found. So one cannot say that all cases get good results from mere drainage.

## CHOLELITHIASIS

DOCTOR LEWISOHN presented a man, thirty-five years old, who was admitted to Mt Sinai Hospital March 10, 1932. He stated that he had his gall-bladder removed for cholelithiasis five years before at another hospital. After a free interval of eight months the pains recurred, lasting for about three weeks. Again a free interval followed which lasted two years. Recently his attacks have recurred every two months with high fever and jaundice. He was moderately icteric, complaining of upper abdominal pains. A scar in the right upper quadrant showed the site of the previous operation. No ascites. The pain gradually subsided. However, it recurred about one week later. Amylase reaction (38) was markedly elevated, as compared to the normal figure of 5 to 7. This corroborated the impression of acute pancreatitis. White blood-cells numbered 35,000 with 90 per cent polymorphonuclear lymphocytes.

X-ray examination of the abdomen showed a large ring-shaped shadow near the sacro-iliac synchondrosis, which had the appearance of a gall-stone. Study of this shadow both by barium meal and barium enema showed the mass to be definitely extra-intestinal.

An exploratory laparotomy was performed through the old scar April 4. The free peritoneal cavity was entered. A large fecolith was found in the appendix (Fig 2). The appendix did not show any signs of acute inflammation. The appendix was removed.

After freeing extensive adhesions the common duct was exposed and incised. About fifty stones were evacuated. Some stones were faceted, others non-faceted. After removal of these stones one large stone was felt at the papilla of Vater which could not be pushed upwards. This stone was removed through a retroduodenal choledochotomy. The incision was closed in two layers. A tube was inserted into the common duct, three packings were put around the tube and the abdominal wall was closed.

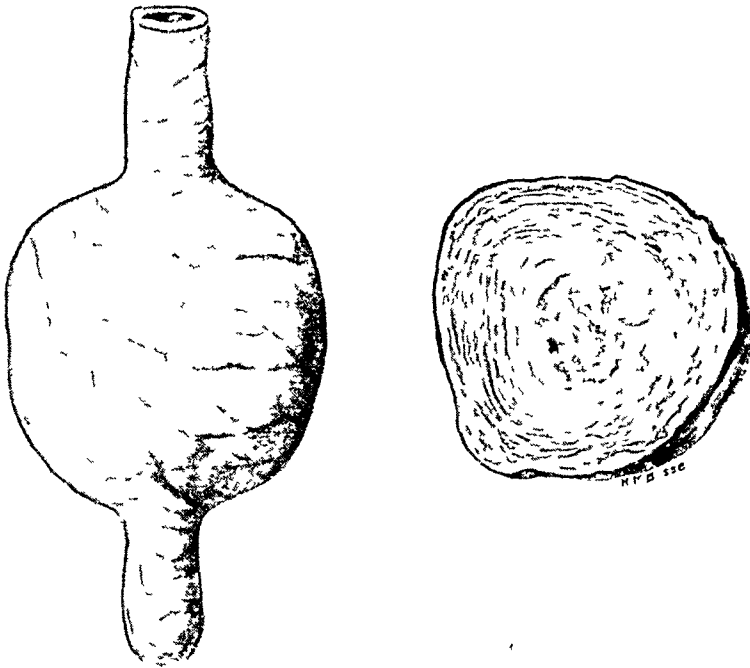


FIG 2—Large fecolith in the appendix.

DR ALLEN O WHIPPLE said that apparently stones had recurred in this patient after cholecystectomy. That stones may form in the duct after removal of the gall-bladder is a very unwelcome fact. These cases were formerly believed to be rare and in actual number they are rare, but when they do occur they are very trying and distressing. Some time ago Doctor Whipple operated on a typhoid carrier and after cholecystectomy removed three large stones from the common duct. The duct was irrigated carefully and no other remnants or detritus could be found. The patient remained well for eight months and then had symptoms of recurrence. At the second operation thirty-two faceted stones were removed from the common duct.

A second point of interest was the retroduodenal approach. In some cases

## INTRATHORACIC GOITRE WITH GRAVES' SYNDROME

that is a very valuable manœuvre. He recalled three cases in which he made the incision through pancreatic tissue to get at the duct. None developed a pancreatitis. If the duct is carefully repaired, with drainage from above, this is not a dangerous procedure. The use of a pliable irrigating catheter is of help in some of these common-duct cases. The stones can be washed out when they cannot be palpated. At the Presbyterian Hospital these silver irrigating catheters are used in cases where there is much detritus, sand or stones.

## INTRATHORACIC GOITRE WITH GRAVES' SYNDROME

DR RICHARD LEWISOHN presented two cases of intrathoracic goitre with Graves' syndrome.

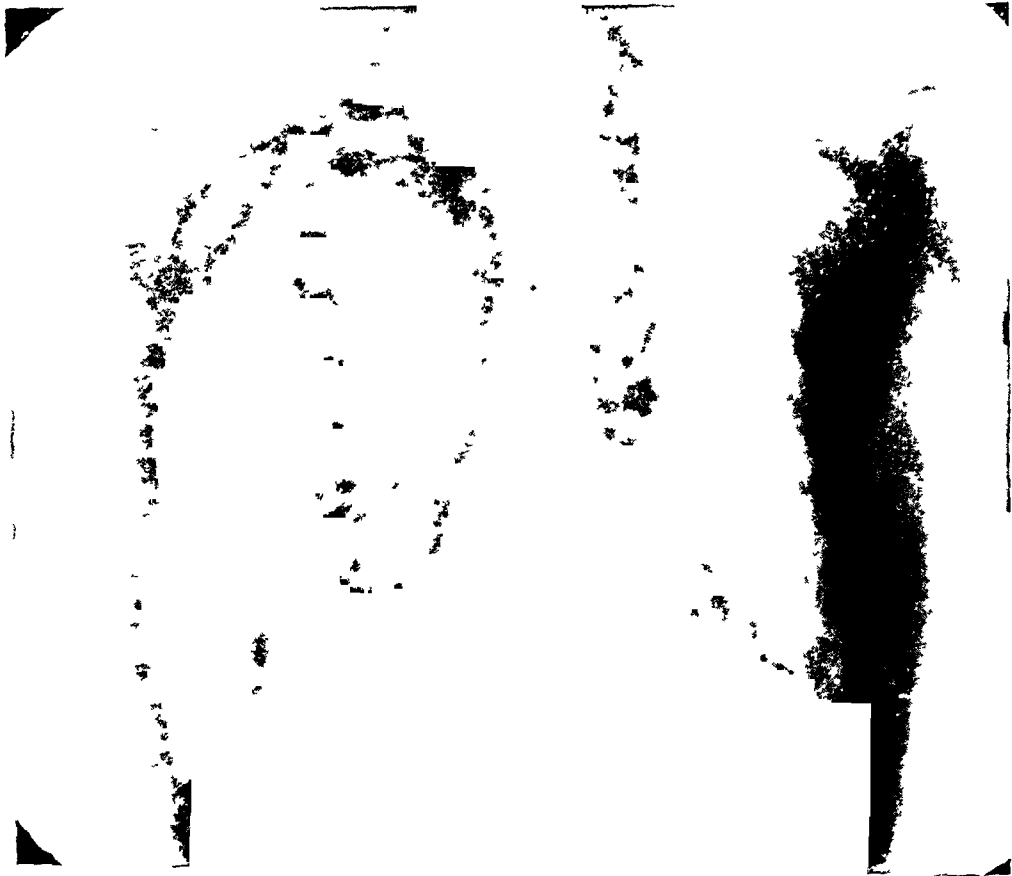


FIG 3—Intrathoracic colloid goitre

CASE I—A woman, forty-two years old, was admitted to Mt Sinai Hospital February 3, 1932. She had noticed a swelling of her neck for many years. She had complained for several months prior to her admission of dyspnoea, palpitation, and nervousness. Her present condition prevents her from doing any work. There was evident a large, hard mass on the left side of her neck, which had pushed the trachea to the right side. The right lobe of the thyroid gland could not be palpated. X-ray examination showed enlargement of the left lobe of the thyroid with considerable calcification. The mass reached intrathoracically to the arch of the aorta. The trachea was displaced to the right side of the neck. (Fig 3.)

After proper Lugolization operation was performed under avertin anaesthesia February 15. Typical collar incision. The long ribbon muscles



of the neck were divided on both sides in order to get proper access. A very large left lobe presented itself. The left upper pole was ligated and cut. The finger was slipped posteriorly down into the mediastinum and a large, partly calcified lobe was lifted out of the superior mediastinum. This lobe was resected and a packing was put into the mediastinum. Closure of wound in typical fashion. Pathological report: calcified adenoma. On the day following the operation the patient showed marked auricular fibrillation. The electrocardiogram showed irregularity due to sinus and also to extra beats. These symptoms subsided in twenty-four hours. The packing was removed on the sixth day. B M. on discharge, 2 per cent. When seen recently patient stated that she had gained eight pounds and that she is able to work. X-ray of the chest is absolutely normal.

CASE II—A woman, sixty-one years old, was admitted to Mt Sinai Hospital October 8, 1932. She had noticed a mass in her neck for forty years, with marked loss of weight (fifty pounds) during the last year. Four

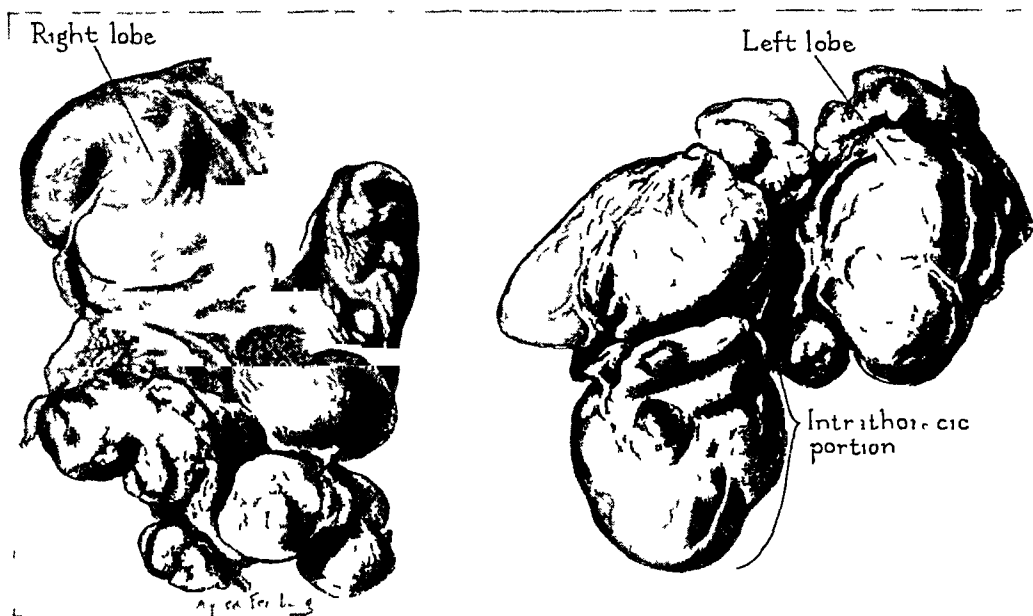


FIG 4.—Goitre mass after removal, intrathoracic extension

months ago, following a fall, she felt oppression in the chest. Other symptoms were dyspnoea, tachycardia, and nervousness. She was a thin woman with a fairly large swelling in the neck and definite auricular fibrillation. A roentgenogram showed a large mass in the upper mediastinum which extended below the level of the aorta and outward beyond the parasternal line. Within the shadow there are a number of areas of calcification. The trachea was markedly displaced to the right and compressed. *X-ray diagnosis*: substernal thyroid with calcification.

Under Lugolization the B M. dropped from 45 per cent to 16 per cent.

Operation November 3. Thyroidectomy. Typical collar incision. The ribbon muscles were split. A couple of independent large nodules presented themselves. The first one to be removed was the middle lobe, which was partly resected and partly enucleated. It was peach-sized. There were two independent large masses on the left side. The upper mass was resected and enucleated. The lower mass extended deeply into the mediastinum. After ligation of the left superior polar vessels this large mass was gently pulled

## INTRATHORACIC GOITRE WITH GRAVES' SYNDROME

out of the chest, adhesions were carefully divided and the mass was enucleated. A large packing was put into the cavity in the mediastinum and the wound was closed in typical fashion (Fig 4). The right lobe was not disturbed. Anæsthesia uneventful. The patient appeared very sick for three days after the operation. The temperature went up to 106°. She was stuporous and had urinary incontinence. She was not restless. Marked fibrillation persisted during this sharp post-operative reaction. Following these anxious days she made a good recovery. The packing was removed on the fifth day. A large sacral decubitus healed under conservative treatment.

Laryngological examination showed a left recurrent paralysis. Her voice is good.

A recent X-ray examination shows a marked decrease in the size of the mediastinal shadow. The trachea is now nearly in the middle line. There are still some calcified areas present on the right side. They may be due to an extension of the right lobe into the upper mediastinum.

DR EMIL GOETSCH said he had never seen an exophthalmic goitre that was intrathoracic. He wished Doctor Lewisohn would explain what he meant by Graves' syndrome in these cases, and whether he was not dealing with toxic adenomata. The speaker did not think the syndrome associated with toxic intrathoracic goitre as in these cases shown was similar to that seen in Graves' disease or exophthalmic goitre. There are no eye signs, no thrills or bruits in the gland and there is an absence of many other evidences of disorder in the sympathetic nervous system. One does, however, find hyperplastic tissue associated with toxic adenoma and this tissue may be responsible for mild eye signs but the diffuse general hyperplasia of the thyroid gland so characteristic of Graves' syndrome is absent.

DR WILLIAM BARCLAY PARSONS said in reference to the nerve weakness following operation in the second case, Doctor Lewisohn had not mentioned if the patient had received a laryngeal examination before the operation. This is of great importance, not only to prove that the cord paralysis existed prior to the operation, but also because hoarseness at times is due to paralysis of the nerve on the opposite side from the tumor. In such a circumstance, extra care must be used not to damage the nerve supply on the side of the tumor, which would result in a bilateral nerve palsy. In any doubtful case, operation under local anæsthesia is indicated. In reference to technic, in Pemberton's original article in the Archives of Surgery, vol 11, p 1, January, 1921, there is a clear exposition of the safest technic. First of all, adequate exposure is essential, and secondly, the attack on the gland is planned to avoid bleeding from the inferior group of vessels. He points out the danger of inserting the finger into the thorax to pry up the tumor mass, which practice may be followed by bleeding in the depths while the thoracic aperture is blocked by the goitre. Any one who has suffered this distressing experience, and has followed Pemberton's technic, will never go back to the other method.

DOCTOR LEWISOHN, in closing the discussion, replied to Doctor Parsons that the larynx was examined before operation in the sixty-one-year-old patient, in which there was a post-operative paralysis of the left vocal cord.

These cases of intrathoracic goitre look more dangerous before operation than they really are. A laryngologist is always present at the operation and is ready to introduce a bronchoscope immediately, if it should be necessary.

Pemberton pointed out the value of immediate ligation of the upper pole in order to be able to lift up the mass out of the mediastinum, whereas Lahey added the procedure of slipping the fingers along the posterior wall of the adenoma and thus separating it carefully from the surrounding tissues in the upper mediastinum.

In answering Doctor Goetsch's question Doctor Lewisohn stated that these two cases belonged clinically to the group of hyperthyroidism in spite of the fact that the pathological report classified them as colloid adenomata. Both cases were admitted with an elevated B.M. The second case not only showed marked fibrillation during her pre-operative stay in the hospital, but had a severe post-operative reaction with high temperature and unconsciousness extending over a number of days. A clinical picture not seen in non-toxic goitres.

#### LARGE INTRATHORACIC GOITRE

DR RICHARD LEWISOHN presented a woman, forty-three years old, who was admitted to hospital December 21, 1932. She had noticed a swelling of the neck for seventeen years. Considerable dyspnoea was noted in the last few years. The patient did not present symptoms of thyrotoxicosis. The swelling of the neck was very large. B.M. + 3 per cent. It was evidently a large colloid goitre occupying the right lobe, left lobe, and the isthmus. X-ray examination of the chest showed a dense shadow which extended downward from the root of the neck into the thorax and below the aortic arch for a distance of about one and one-half inches. This is probably a large substernal thyroid which has depressed the aortic arch.

Under avertin anaesthesia a long incision was made at the lower part of the neck. Skin flap was pushed back and the long muscles of the neck were split on both sides. Right lobe was then brought forward, and the upper pole was ligated. The right lobe did not extend into the thorax. The left upper pole was then freed and ligated. This pole was cut distal to the ligation. The left lobe extended down into the mediastinum. In order to be able to mobilize this lobe, the large isthmus was cut through between clamps, the trachea was laid bare, and the right lobe and the isthmus resected, leaving only a small amount of goitre tissue behind. After removal of the right lobe and the isthmus, it was possible to mobilize the left lobe sufficiently so that the hand could be carried along its posterior aspect down into the mediastinum and the intrathoracic part of this goitre could thus be lifted up without incurring any bleeding. The left lobe with its intrathoracic extension was then resected, leaving a small stump behind on the left side. The stump on the right side was then sewed over with a few interrupted stitches. The left stump was not sewed over as it was very small. Hemostasis was complete. Bronchial collapse did not occur after the removal of this huge goitre. Breathing was unimpaired. A packing was put into the upper mediastinum. The muscles were sutured with catgut and the skin closed with clips.

The post-operative course was uneventful aside from transitory fibrillation on the second day after operation, which subsided without medication. The packing was removed on the sixth day post-operative.

## SURGICAL CONDITIONS OF THE SUBDELTOID BURSA

## SURGICAL CONDITIONS OF THE SUBDELTOID BURSA

DR JAMES MORLEY HITZROT read a paper with the above title for which see page 273

DR HENRY W CAVE asked Doctor Hitzrot how long one should wait after the acute stage of the bursitis had subsided before operation was indicated. Also Doctor Cave felt that in many of these cases the bursitis would clear up without operation. About four years ago Doctor Cave saw a man with bilateral subdeltoid bursitis, X-rays demonstrated calcification in both bursæ. The man refused any operative interference being at the age of sixty, and after a twelve-months' period other X-rays were taken and showed that the calcification of the bursa had disappeared, the patient being entirely free of pain or distress of any kind. Another instance of a left subdeltoid bursitis came under Doctor Cave's observation. Calcification had taken place in this bursa. No operation was performed. X-rays were taken every three months and at the end of about eight months calcification had disappeared and the man was completely free of all symptoms. Doctor Cave admits that there are certain types of bursitis requiring operation, especially where bony fragments have been pulled off around the joint, but he feels many of these cases clear up without operative intervention.

DR EDWIN BEER asked Doctor Hitzrot in what percentage of subdeltoid bursitis cases he thought an operation should be done. Apparently he has operated on a considerable number of these cases, whereas Doctor Beer felt that conservatism in the treatment of this condition was the proper attitude to take. Wet dressings, gentle massage and diathermy with abduction treatment as recommended by the late Walter M. Brickner usually relieved these patients of their symptoms. The cases of bilateral calcification are often encountered without any symptoms, and frequently one sees symptoms on one side, though the calcification may be more marked on the other side and absent on the side on which the disability and pain are manifest. As Doctor Beer recalled it, Doctor Brickner originally was also rather radical and had operated upon these cases of calcification in the subdeltoid bursa. Before he died, he was much more conservative, and operated very rarely for this condition. With this conservative attitude Doctor Beer was in complete harmony.

DR DONALD GORDON wished to know what indications were required for operating. In the largest calcified bursa he had ever seen he had believed operation was required but this was not done and the physician who showed the case to him had later reported that it disappeared in one week after three diathermic treatments. Doctor Gordon also wanted to know what treatment was given post-operatively. He had seen a case with bilateral calcification. One side was operated on but became infected. The patient refused operation on the other side and had to receive other treatment. It is easy to operate on these cases but it is not easy to find the calcification and if anything goes wrong one leaves as much pathology as one approaches. Operations on these cases should undoubtedly be done only by a man with considerable experience.

DOCTOR HITZROT, in closing the discussion, said that his attitude toward treatment of these cases was like that of others who had operated on them for many years, but do not operate on as many now. He did not operate on the acute cases in which there is a calcium deposit under the floor of the bursa. It is not unusual to have cases recover that use no treatment other than a simple electric pad. There are cases that may or may not show the deposit but later, on taking another X-ray, the calcarious deposit will be found. If the patient is left alone and given graded exercises many of these deposits will disappear, and operation is not necessary. The group that require operation have recurring attacks with residue left for years and recurring disability. In these the deposit does not disappear. In the former cases one may be conservative, it is in the cases with recurring attacks with recurring disability that one must operate. With regard to massage it is contraindicated because it is extremely painful and makes them worse. Five of the cases in this series were physicians, all of whom had had diathermy, and they said it was so painful they were sorry they ever tried it. Doctor Hitzrot said he had never seen any relief from diathermy. Hot moist dressings in the early, and in the late cases hot dry heat is more comforting than diathermy.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 2, 1933

The President, DR JOHN SPEESE, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

### ADRENAL TUMOR PRODUCING THE ACHARD-THIERS SYNDROME

DR THOMAS A SHALLOW called attention to certain clinical and pathologic manifestations occurring as a result of disorder of the adrenal glands. Much confusion still exists as to the exact pathology present in this disorder. He wished to particularly emphasize that the Achard-Thiers syndrome occurs primarily from disorder of the adrenal gland and that the other ductless glands are secondarily involved as a result of dysfunction of the adrenal.

Hypernephromata springing from adrenal rests situated in the kidney are never associated with any sex variations. Abnormalities in sex development and genital malformations are not limited exclusively to adrenal cortical hypersecretion. Other ductless glands are credited with the power of producing abnormal sex manifestations either in the presence of tumor or hypersecretion. When abnormal sex deformities are present, due to pituitary and pineal glandular disturbances, there are associated with the sex phenomena other clinical manifestations which identify the origin of the disease.

Physiologic variations in the size and morphology of the adrenal cortex have been observed by Stilling in his study of animals during the breeding season. Hager noticed in humans during pregnancy an increase in the amount of hair on the face and body which he attributed to adrenal cortical enlargement. Atrophy of the adrenals associated with loss of hair, diminution in size of the uterus and ovaries and cessation of menstruation have been observed by Karakascheff and Weisel. Karakascheff reported the case of a mother of two children, who at the age of twenty-seven ceased menstruating and died at thirty-nine. At post-mortem there was no hair on the axilla or mons. The uterus and ovaries were very small and the suprarenals almost entirely absent. Weisel describes a girl, aged eighteen, without genital or axillary hair. At post-mortem both adrenals were very small. Microscopically the cortex of the adrenal was normal, but there was noticed a general atrophy of the whole chromaffin system.

The pathologic manifestations of adrenal disorders are

(1) Pseudohermaphroditism. This is always a congenital defect, the result of some change in embryologic development. It is associated with

changes in body structure and changes resembling the external sex organs of the male type and internal sex organs of the female

(2) Adrenal precocity occurs as the result of tumor in either the male or female child during the first decade

When the tumor occurs in a male child there are no female sex characters but an increase in masculinity. This is manifested by increase in strength, increase in stature, development of hirsutism and enlargement of penis and testes. This is well exemplified in a case reported by A. Dingwall Fordyce, occurring in a child two years old. The baby was healthy at birth, breast fed for fifteen months. He weighed  $9\frac{3}{4}$  pounds at birth and 42 pounds at eight months. He never ailed and became fat and strong. At the age of six months, the mother noticed that there was hair on his pubis and that his penis was very big. At the age of eight months a rash was observed on his back which persisted and gradually spread. He had a deep-toned voice and he walked at the age of twenty months. Shortly after this period, he carried a bucket of coal weighing 18 pounds. His systolic pressure was 80 mm and diastolic pressure 50 mm. A left adrenal tumor the size of an orange was removed. The microscopic examination showed the neoplasm to be an adrenal tumor.

From this it will be gathered that even at the early age of two years, adrenal tumor in the male is associated with increase in strength and the development of sex characteristics of abnormal proportion.

When an adrenal hypersecretion occurs in the female before the age of puberty, the child loses the female characteristics and assumes those of the male, the enlarged clitoris resembling a penis, the development of pubic and axillary hair and precocity.

(3) Adrenal virilism occurring after maturity, according to Gordon Holmes, is manifested by

(a) Atrophy of the uterus and overgrowth of the clitoris

(b) Disturbance of sex functions, manifested by cessation of menstruation

(c) Physical changes—loss of erotic feelings and lack of modesty

The belief that adrenal tumors cause sex variations in male and female is confirmed by the improvement and the cures resulting from the removal of the tumors. In the cases reported by Gordon Holmes, Fordyce and others, there was return of normal sex characters and function.

(4) Achard-Thiers symptom complex varies considerably from the other syndromes previously described. In this syndrome the pathologic process primarily involves the adrenal in the form of hyperplasia. There is associated with adrenal hyperplasia a polyglandular disturbance. Achard-Thiers classified this syndrome as "diabetes of bearded women." At post-mortem, not only do the adrenals show hyperplastic change but also there is associated other ductless gland pathology, namely, pericanalicular sclerosis of the pancreas with increase in the islets of Langerhans, ovarian sclerosis and atrophy, cirrhosis of the liver and colloid hypersecretion of the thyroid, the pituitary

gland being normal. The chief symptom of this syndrome is hypertrichosis of the face of masculine distribution. The other signs of virilism are not present—the breasts and external genitalia are normal, the internal genitalia being characterized by disturbance of menstruation. There is usually amenorrhea or irregular menstruation. These individuals are obese, have glycosuria and a decreased carbohydrate tolerance. Hypertension is observed. These authors were of the opinion that the adrenal changes played an important part in the etiology of this condition, but were probably not the primary cause (Gloucester, Hill and Greenfield). As an illustration of this condition the speaker reported the following case:

A white female aged twenty-seven, single. Chief complaints: Obesity of face and lips, one year duration, superfluous hair over the body, one year duration, weakness of arms and legs, seven months duration, lancinating pains in the arms and legs, four months duration, palpitation of the heart and swelling of the ankles, enormous appetite, two months duration.

*Physical examination*—Aside from the above group of symptoms the physical examination was essentially negative, except that at times the patient complained of a dull boring pain in the left hypochondrium and loin. Because of her obesity the tumor was not palpable. The X-ray examination disclosed a large kidney on the left side. The X-ray of the skull showed normal sella turcica.

*Laboratory findings*—Blood pressure ranged from 140 to 220. Urinary examination negative for diseases of the kidneys. The blood chemistry showed no marked variations from the normal, except for a high carbohydrate tolerance (278 at the end of two and one-half hours). The breasts and external genitalia were normal. Pelvic examination by Dr. P. Brook Bland disclosed no abnormalities.

The syndrome manifested by this patient resembles closely the Achard-Thiers syndrome but differs in some respects. Achard-Thiers questioned the primary site of the etiologic factor. They believed it to be due to adrenal hyperplasia. This patient had a primary malignant tumor which caused the symptom complex. She likewise differs from the Achard-Thiers group in that metrorrhagia with irregular menstruation was a prominent symptom. She was even operated upon for the control of metrorrhagia. An additional variation is the presence of a high carbohydrate tolerance. While these differences may be differences in degree, they are not differences in fact, they emphasize the primary site of the pathologic lesion (adrenal disorder) (Fig. 1).

Successful removal of the adrenal tumor was not followed by the improvement anticipated. The patient left the hospital in excellent condition and was readmitted under Dr. Reynolds Griffith five months after the operation. While in the hospital the patient still complained of weakness, palpitation, lightning pains in the extremities and obesity. The patient then became glycosuric. The urinary sugar daily present ranged from 3 per cent to 9 per cent. Secondary anemia appeared. There were changes in the size, shape and staining characteristics of the red blood cells. The X-ray examination disclosed metastases to the lungs (Fig. 2).

From these observations the speaker concluded that, (1) the Achard-Thiers syndrome is not always associated with adrenal hyperplasia but adrenal tumor can produce this symptom complex, (2) glycosuria was a late manifestation in this patient, it was not in evidence until after the



removal of the tumor, (3) apparently low grade malignant tumor, well encapsulated, metastasized early, even in the presence of apparently complete removal, (4) metastatic growths are capable of continuing this symptom complex after the removal of the tumor

The pathological examination of the tumor removed showed the specimen to consist of two, somewhat irregularly shaped, rather soft nodular masses of tissue, which together weigh 67 gms. The two masses were separated after removal of the tumor. One mass is slightly larger and is somewhat bean shaped, measuring  $6\frac{1}{2}$  by  $4\frac{1}{2}$  by 4 cms. It is encapsulated, rather soft, nodular on the surface and contains a small amount of attached fat and ragged tissue. On one surface there is a cavity where the other part of the specimen had been continuous with this. On section, it is composed of a light yellowish, homogeneous tissue which forms distinct nodules in places. One nodule which seems to be encapsulated is composed of much lighter yellow tissue than the surrounding tissue, and measures  $2\frac{1}{2}$  cms in diameter. Small areas are soft and seem to be undergoing necrosis. The other mass which measures  $5\frac{1}{2}$  by 4 by  $2\frac{1}{2}$  cms, is also rather soft, nodular and of a darker brownish color than the first described.



FIG 1

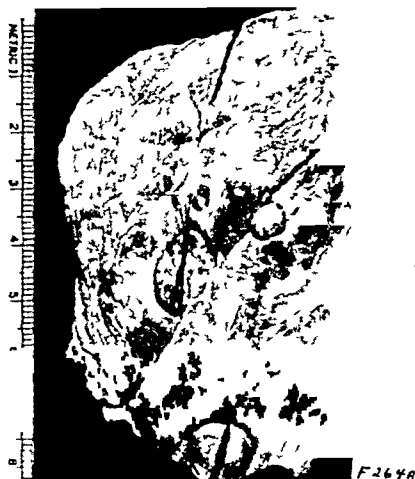


FIG 2

FIG 1—Adrenal tumor removed at operation. Complete operative recovery.  
FIG 2—Showing metastatic nodules in the lungs present five months after the removal of the tumor. X ray of lungs negative at time of operation.

one. On section, this tissue is very friable, solid and is composed of this homogeneous brownish liver-colored tissue throughout.

*Histology*—Examination of sections from the larger of the two masses of tissue reveals that it is composed of large, rather clear cells, with relatively large faintly staining nuclei and a large amount of clear cytoplasm. These cells are arranged to form distinct nodules. There is comparatively little intracellular fibrous tissue present and only in small areas is there a suggestion of the normal arrangement of the rows of cells seen in the adrenal cortex. For the most part, the cells have no characteristic arrangement but are loosely held together by a small amount of fibrous tissue stroma in which there are numerous small blood vessels. In some areas the large clear cells predominate and in other areas the cells are small and the cytoplasm contains more granular material. This mass has a very definite capsule but clumps of the cells can be observed in the fibrous capsule. The growth is very vascular in areas with rather large, endothelial-lined spaces separating clumps of the tumor cells. Small areas of necrosis are scattered throughout the tissue.

The small separate mass is composed of somewhat similar cells, but these cells are not so large, the cytoplasm is more granular and contains more pigment and groups of the cells in areas are distinctly oxyphilic. No medullary cells were observed in

## EFFECTS OF RONTGEN RADIATION OF THYROID

any of the sections examined from either mass of tissue, and sections from 8 blocks of tissue were examined from various portions of the two specimens

The growth seems to be composed entirely of the cortical cells and in some areas the cytoplasm of the cells contains much more pigment and is much more granular than in others, giving the difference in color. Because of the lack of orderly arrangement and the distinct nodules, the lesion is considered to be neoplastic rather than a hyperplasia. While the mass seems definitely encapsulated from the rather bizarre appearance and arrangement of the cells in areas and the vascular nature of the growth, it probably should not be considered entirely benign. *Diagnosis*—Adenoma of the adrenal cortex

The speaker said that the case of adrenal tumor just presented is a clear-cut well-defined illustration of Achard-Thiers syndrome. While there may be a question of pituitary involvement in some of the reported cases of adrenal tumor, other clinical manifestations are likewise present which denote the existence of other associated ductless glands

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## EFFECTS OF RONTGEN RADIATION OF THE THYROID PARATHYROID GLANDS UPON THE GROWTH OF A GIANT-CELL TUMOR OF THE RADIUS

DR GEORGE W WAGONER presented a thirty-one-year-old white man who had been under treatment for a proven giant-cell tumor involving the distal end of the left radius. Surgical removal of the tumor and intensive local X-ray irradiation of the tumor-bearing area failed to prevent recurrence of the growth. Amputation at the mid-forearm was advised. Before resorting to this radical procedure the patient was studied from the standpoint of his calcium-phosphorus metabolism. It was found that the blood calcium was markedly increased (15.9 mg per 100 cc) and blood phosphorus was normal (4 mg per 100 cc). Though no thyroid or parathyroid mass was grossly demonstrable the patient was given over a period of fifteen days and in 5 divided doses  $1\frac{1}{2}$  erythema doses of X-ray irradiation to the thyroid area.

Following this irradiation the local wrist pain disappeared, the mass became less fluctuant and decreased in size and the blood calcium and phosphorus content gradually approached a normal level and relation. Associated with these changes the basal metabolic rate fell from plus 4 before thyroid-parathyroid irradiation to minus 24 six weeks after completion of irradiation. Seven months after completion of irradiation the basal metabolic rate had risen to minus fourteen. Serial roentgenograms showed a progressive calcification of the tumor mass. The patient was able to resume his work without disability four weeks after completion of local thyroid-parathyroid irradiation.

An examination made seven months after glandular irradiation found the calcium-phosphorus relationship and blood content to be approximately normal, the tumor site to be completely and densely calcified and the patient

## PHILADELPHIA ACADEMY OF SURGERY

free from pain and local disability excepting for slight limitation of wrist-joint motion

DR THOMAS A SHALLOW said that from the improvement presented in Doctor Wagoner's paper there does not seem to be very much doubt of the beneficial effect of the X-ray in controlling hyperparathyroidism. One must question the advisability of the use of the X-ray in this disorder if there was a palpable thyroid gland present. In event of the presence of a definitely palpable tumor it would seem better to remove the parathyroid gland rather than to subject the thyroid and all of the parathyroids to the effect of X-ray therapy.

DR GEORGE WAGONER said that this single case does not prove that parathyroid irradiation will cure giant-cell tumor nor did he intend that such inference be taken. Several other cases of giant-cell tumor are now under treatment by parathyroid irradiation alone. The progress being made in these cases is extremely gratifying. As to the preference for irradiation as opposed to parathyroidectomy, he feels that the former is preferable in as much as it is possible to grade the dosage and hence control the degree of "dampening" of parathyroid hyperfunction. Furthermore irradiation can be repeated at frequent intervals over long periods of time if necessary. The simple procedure of irradiation is preferred by patients to that of operative removal of the parathyroids.

### REVIEW OF FORTY-TWO CASES OF CARCINOMA OF THE BREAST

DR GEORGE M DORRANCE presented a preliminary report on an analysis which he had made in 42 cases of carcinoma of the breast treated by radical operation. These patients had been operated upon in a number of clinics, eventually coming under Doctor Dorrance's care at the American Oncologic Hospital whither they had been sent on account of recurrence. Doctor Dorrance was presenting his report at this time without comment on recommendations as to the best plan of treatment to be adopted in breast cancer. He was reserving his opinion until a more complete study of the data had been made. This will be presented at a future meeting of the Academy.

### SURGERY OF DIABETIC GANGRENE

DR ELDRIDGE L ELIASON pronounced the annual oration on the the above entitled subject for which see page 1 of the July, 1933, issue of ANNALS OF SURGERY.

# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY AND THE PHILADELPHIA ACADEMY OF SURGERY

JOINT MEETING HELD FEBRUARY 8, 1933, AT BELLEVUE HOSPITAL,  
NEW YORK CITY

## LUMBAR SYMPATHETIC NEURECTOMY FOR HIRSCHSPRUNG'S DISEASE

DR EDWARD J DONOVAN presented a man, aged twenty-four years, who, in May, 1921, when twelve years old, was first admitted to St Luke's Hospital, New York, complaining of constipation since birth. X-ray at that time disclosed a dilatation of the colon, but it was thought to be acquired rather than congenital in spite of the fact that no cause for it could be found. He was discharged eighteen days later on cascara and milk of magnesia, and it was stated in the discharge note that his bowels were moving well. He was readmitted one year later with fecal impaction and a history that for several months past his bowels had moved only once or twice a week. Impaction was removed, X-rays taken showed that the sigmoid and descending colon were very large. July 22, 1922, Doctor Bolling removed twenty-four inches of the sigmoid and did a side-to-side anastomosis. Convalescence was uneventful. He was discharged twenty-two days later with satisfactory bowel movements as result of a daily enema. Pathological diagnosis of the colon was megacolon. All the muscular coats were hypertrophied.

Three years after this operation he was again admitted with fecal impaction. He had felt improved for two years after his operation, but now his condition was just as bad as ever. An X-ray taken at this time was reported as showing great dilatation of the colon. He was also shown by Doctor Bolling at the New York Surgical Society about this time to demonstrate the fact that he believed resection in these cases was hardly worth while as the condition recurred promptly in the remaining colon.

January 15, 1932, he was admitted on account of a fecal impaction which was so great that it was necessary to give him an ether anæsthetic to remove the impaction. His X-ray at this time showed the rectum and sigmoid tremendously dilated with considerable dilatation of the descending, transverse and ascending colon. February 9, 1932, a sympathectomy was done. There were many adhesions around the site of his previous operation which it was necessary to dissect. The sigmoid and rectum were so large that it was necessary to mobilize them to remove them from the field of the contemplated sympathectomy. This operation was done under spinal anæsthesia which was a great help in keeping the large intestine out of the field of operation. The peritoneum in the mid-line of the posterior abdominal wall was incised directly over the bifurcation of the aorta. This incision was carried downward over the brim of the pelvis to the left common iliac vein and upward to the origin of the inferior mesenteric artery. The pre-sacral nerve was then found just to the right of the left common iliac vein. In 80 per cent of the cases that have been operated upon, the pre-sacral nerve exists as three trunks. In 20 per cent of the cases, these three trunks are fused to form a single nerve. This is the condition, a single trunk, that existed in this case. The pre-sacral nerve was then cut below just before its entrance into the hypogastric ganglia, and dissected upward to the origin of the in-

ferior mesenteric artery as this is the method recommended in finding the inferior mesenteric nerves which lie one on each side of the inferior mesenteric artery. In this dissection from below upward, the connecting branches from the third lumbar ganglia are divided as they pass beneath the common iliac arteries. Branches from the first and second lumbar ganglia are then severed as the nerve is traced upward. About one inch of each inferior mesenteric nerve was then resected with the pre-sacral. The incision in the peritoneum was then closed and the abdomen closed in layers. He had a slight upper respiratory infection with a troublesome cough that bothered him quite a little but it was not considered post-operative pneumonia. His convalescence was otherwise most uneventful. On the third day after operation he received his first enema which was expelled with much force. He was very much pleased with this result and stated of his own free will that it was the first time in his life that he could remember being able to expel an enema. He was given half an ounce of mineral oil t.i.d. and a daily enema for the twelve days that he was in bed with equally good results each day. His bowels moved spontaneously before he received his enema the first day that he was out of bed. He has had mineral oil only since he left the hospital and has one or two very satisfactory bowel movements every day.

CASE II—A twelve-year-old Jewish girl was admitted to the Babies Hospital, November 17, 1932, for the second time with complaints of abdominal distention, vomiting and failure to move her bowels for the past several days. She was a known case of Hirschsprung's disease, the diagnosis having been made when she was three days old. She was one of twins, the other twin having died at the age of three days, probably from the same condition as her abdomen was very much distended, and she had passed nothing by rectum.\*

Since birth this patient, whom he presented, has had to have a daily enema with frequent cathartics and mineral oil. In spite of this treatment, she has often gone several days without having a bowel movement. Three years ago, she was also under treatment for intestinal obstruction due to impacted feces. By means of numerous hot oil enemata, colonic irrigations and the manual removal of feces, the obstruction was relieved. Operation was advised at this admission, but was refused. Since that time she has been seen frequently in the clinic.

A sympathectomy was done December 6, 1932, a resection of the pre-sacral with both inferior mesenteric nerves in the usual manner by incising the peritoneum in the mid-line over the promontory of the sacrum. The pre-sacral nerve, which existed as one single cord, was picked up in the region of the left common iliac vein, and dissected upward to the inferior mesenteric artery where about one inch of each inferior mesenteric nerve was removed with the pre-sacral.

The patient had an uneventful convalescence, had a spontaneous bowel movement on the thirteenth day after operation, and was discharged from the hospital on the seventeenth day at which time she was able to expel an enema forcefully.

It is now two months since her operation. Her bowels are moving once or twice a day, and she is having nothing but mineral oil twice a day by

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\* These cases were reported as Hirschsprung's disease by Dr. Joseph Popper in the New York Medical Journal, December 25, 1920. He was the physician who attended her since she was three days old.

## LUMBAR SYMPATHETIC NEURECTOMY

mouth A barium enema a few days ago shows considerable decrease in the size of the colon The patient has gained weight, her abdomen is very much smaller, and she is feeling better than she has felt in years

DR EDWARD W PETERSON (New York), said that three cases of Hirschsprung's disease had been subjected by him to lumbar sympathectomy since January, 1932 In the first and third cases the pre-sacral, the inferior mesenteric nerves, and the left lumbar ganglia were resected, in the second case the pre-sacral and inferior mesenteric nerves, as recommended by Rankin, were resected The relief of symptoms was most gratifying in all three cases He had reported these cases on November 9, 1932, before the New York Surgical Society One of these cases, the most advanced and the least promising, had movements on February 2, 1932 At the present time the bowels are moving normally and naturally each day without any medication, and his abdominal distention is no longer present The apathy and lassitude, so pronounced before operation, have entirely disappeared He has gained twenty-five pounds in weight, and several inches in height His general health is excellent and his whole outlook on life has improved

Hirschsprung, in 1886, described the disease which has since borne his name as "a condition of congenital high-grade dilatation of the colon, with thickening of all its tunica, especially the tunica muscularis, and retention of large quantities of fecal matter" The dilatation and hypertrophy may affect a part of or the whole of the large bowel To the cardinal symptoms—dilatation of the colon, abdominal distention and obstipation—may be added languor, apathy, loss of weight, anæmia and general muscular weakness Occasionally there may be abdominal discomfort, vomiting, fever, and evidences of auto-intoxication Usually when diarrhoea occurs it is merely the overflow of fecal retention

The treatment of idiopathic dilatation of the colon in the past, by both medical and surgical measures, has, for the most part, proved unsatisfactory Following the work of Hunter and Royle, of Sydney, Australia, Wade and Royle, in 1927, reported a case of Hirschsprung's disease, treated by ramisection of the lumbar sympathetic ganglia, with excellent results Later Judd, Adson, Rankin, Learmouth, of The Mayo Clinic, Wade, Robertson and others gave encouraging accounts of their experience with this operation There were no deaths recorded All cases, it seems, were benefited and the end-results, in properly selected cases, were "spectacular" (Rankin)

There are many theories as to the cause of Hirschsprung's disease, which will not be discussed here It seems probable that the underlying factor is neurogenic, for there is definite neuromuscular imbalance and dysfunction, and the colon seems incapable of emptying itself of the large fecal accumulations Section of the lumbar sympathetic nerves causes a break in the hyperactive inhibitory control The relative safety of the operation and the highly gratifying results obtained by a number of surgeons make this procedure the method of choice in the treatment of properly selected cases of megacolon

DR THOMAS A SHALLOW (Philadelphia) said that since 1886 when Hirschsprung first wrote his article on this condition, which bears his name, there has been a gradual understanding of the pathological lesion. It is accepted, by most, that Hirschsprung's disease originates as a result of some intrinsic disturbance in the wall of the colon, at the junction of the sigmoid and rectum. As a result of this disorder the sigmoid, some of the colon and indeed, in some cases, all of the colon becomes hypertrophied, thickened and elongated. The management of this condition from the time of its description to the year of 1923 was more or less haphazard. Appendicostomy, ilio-colostomy, colectomy and resection of the bowel were performed. Because of the relatively high mortality by these methods of treatment many patients selected the medical plan of treatment.

In 1923, Royle wrote his epoch-making article on the surgical treatment of the sympathetics to control this disorder. Royle believed that the removal of the second, third and fourth lumbar sympathetics removed the inhibitory influence of the sympathetic nerves. That this belief was founded on fact there is no question, numerous cases in literature and some done by myself certainly justify this operation. However, with the increase in our knowledge of the sympathetic nerve system, and with the disease in question, it was found that the lesion was not limited to the sigmoid but also involved, in most cases, the descending colon.

In 1927, Wade, of Australia, developed a new operation for the management of this condition, it was his belief, and this belief has been fortified by subsequent observers, that it was unnecessary to subject the individual to the extensive operation of ganglionectomy. It is now known, conclusively, that the sympathetic inhibitory nerve fibres to the descending colon have their origin in the upper sympathetic ganglia, the semilunar and the celiac plexus, from these plexuses the sympathetic fibres pass along the aorta from the superior mesenteric to the inferior mesenteric artery. Between these two structures the sympathetic nerve system is known as the intermesenteric plexus. It is from this plexus that the inferior mesenteric nerve has its origin. The distribution of the inferior mesenteric nerve is to the middle and descending portion of the colon. Not only does the colon receive the sympathetic nerve supply, of the inferior mesenteric nerve, but it also receives, from the second, third and fourth lumbar ganglia, the pre-sacral sympathetic nerve. The method of formation of the pre-sacral nerve is interesting from an anatomical standpoint but from a surgical standpoint it is no more important than the inferior mesenteric nerve.

Therefore, the plan of procedure for the treatment of Hirschsprung's disease, which includes the removal of the inferior mesenteric nerve and the pre-sacral nerve, is based on sound anatomical and physiological facts.

DOCTOR PETERSON added that at present one did not know how much or how little to do in resecting the lumbar sympathetic nerves in Hirsch-

## LUMBAR SYMPATHETIC NEURECTOMY

sprung's disease Wade advocated, through a long incision in the flank, an extra-peritoneal division of the mesially directed branches and the main chain itself below the fourth lumbar ganglion Judson and Adson have advised, through a transperitoneal operation, the resection of the second, third and fourth lumbar ganglia on both sides Rankin and Learmouth believe that resection of the pre-sacral and the inferior mesenteric branches will sever all the nerves to the parts of the bowel chiefly affected, thus avoiding the minor disadvantage of disturbing the neurovascular supply of the lower extremities

DR FREDERICK A BOTHE (Philadelphia), said that surgeons who prefer the operation that Doctor Donovan has employed in these two cases, to lumbar ganglionectomy, believe that the nerve section is limited to the actual fibres supplying the intestine, that this procedure insures the interruption of all the fibres reaching the distal part of the colon from the thoracico-lumbar sympathetic outflow The anatomical and physiological reasoning is that first we may attempt to diminish the dilatation of the colon, and leave its motor nerves in less disputed control by division of the inferior mesenteric nerve, and attempt to relieve any opposition to the expulsion of the contents of the bowel offered by the internal sphincter of the anus, by the division of the pre-sacral nerve

The lower end of the pre-sacral nerve should be clamped before it is cut, to avoid hæmorrhage Should hæmorrhage occur, difficulty may be experienced in controlling it, and damage to the pelvic plexus and sacral nerves may result Injury to the pelvic plexus may result in disturbances of micturition, and injury to the sacral nerves may result in a disturbance of the reflex of defecation He reported a case which was operated upon by Doctor Speese at the Presbyterian Hospital in Philadelphia

The patient, G H, was born in the maternity department of the Presbyterian Hospital in 1929 After birth the child did not take feedings well, vomited considerably, and abdominal distention gradually developed The bowels moved with difficulty and even rectal irrigations were not very successful Rectal examination revealed a stricture which felt like a membranous band just at the tip of the little finger A catheter was introduced with difficulty past this constriction A copious evacuation of foul fecal material was obtained and an abundance of gas was passed with total relief of distention A barium enema was given with the catheter in place, and it showed a marked degree of dilatation of the entire colon Subsequently, the infant proctoscope was passed its full length, no evidence of obstruction was found, and the mucosa appeared normal The child remained in the hospital for a period of five months On a few occasions it had a natural bowel movement, but daily strenuous colonic irrigations were necessary for a complete evacuation The child was thought to be too young to consider sympathectomy at this time, so the mother was taught how to give a colonic irrigation and continued this treatment after dismissal from the hospital Two months later the child was readmitted to the hospital, as home conditions were most unsatisfactory and the mother was unable to care for the child properly Under hospital management and blood transfusions the general health improved



He became more alert and active and gained in weight, but the abdominal distention became progressively more pronounced and successful evacuations became more difficult to obtain by colonic irrigations

When the child was twenty-three months of age, the X-ray report of a barium enema was "The enema passed without delay or discomfort to the child. The entire colon was greatly dilated, the ascending and descending portions considerably more in proportion to the transverse. At two years of age, the pre-sacral nerve and inferior mesenteric plexus were resected by Doctor Speese. There was some post-operative distention for a few days but on the fourth day the child began to have good results from soap-sud enemas and the distention was relieved. Subsequently the child's general condition was definitely improved and the distention was diminished, and on many days natural bowel movements occurred. The patient was discharged thirty-five days after operation. An X-ray study made at this time showed a definite decrease in the size of the descending and transverse colon, and a few haustrations could be seen. There was little change in the ascending colon. One month later the child was readmitted because of improper management at home and a return of the distention. This time the child remained in the hospital for three weeks and at the time of dismissal was again having one to two soft formed stools daily, and the distention was again relieved. Six months after operation the patient was readmitted for follow-up studies. He had grown an inch in height, was much brighter, more alert and active. The abdominal distention had decreased, about 60 per cent. In the course of preparation for a barium enema, he developed a series of convulsions, never regained consciousness, and died in six hours.

#### POLYPOSIS AND CARCINOMA OF COLON, COLECTOMY FIVE YEARS WITHOUT RECURRENCE

DR HENRY F GRAHAM (New York), detailed the history of a woman who was admitted to the Brooklyn Methodist Hospital, November 30, 1927, on account of intestinal disturbances, with discharges of mucus and blood, at intervals during the preceding seven years.

For two months prior to admission she had noticed a tendency to constipation instead of diarrhoea.

At a first operation a large adeno-carcinoma of the sigmoid was drawn out through a lower left muscle-splitting incision and the two limbs of the loop sutured together as in the Miculicz procedure.

The loop was removed nine days later. In addition to the carcinoma several polypi were found in the loop, some of which prolapsed from the upper opening of the colostomy. In a few places carcinomatous degeneration was commencing.

Several transfusions were given and a month after the first operation an end-to-side anastomosis of the terminal ileum to the rectum was made with a Murphy button. By the last of January, 1928, her red cells were normal and the hæmoglobin was 77 per cent. She was allowed to return home for a month and a half. Her stools were somewhat fluid at this time. She gained fifteen pounds in weight and returned to the hospital apparently in perfect health except for occasional blood from her isolated colon.

March 5, 1928, the colostomy was divided, the lower end was closed and the entire colon was removed to a point just about the cæcum. The specimen showed an adeno-carcinoma near the cæcum and numerous adenomata, many

of which were pedunculated, forming true polypi. Two weeks later the remaining cecal pouch and the end of the terminal ileum were removed. There were no polypi in the ileum. She showed wonderful recuperative ability. Every wound, with the exception of the last one, healed without infection.

This patient has remained in good health, a period of five years.

DR DAMON B. PFEIFFER (Philadelphia), remarked that Doctor Graham's case represented a happy solution of a very difficult problem. The desirability of total colectomy in certain conditions is unquestionable. Especially is this true in diffuse adenomatous polyposis of the colon. In the majority of such cases, cancer of the colon is inevitable. And even before such malignant transformation takes place such individuals are often incapacitated by disturbances of the bowels associated with ulceration and continuous loss of blood, sometimes even massive hæmorrhages. It may be possible in certain cases to deal with single polyps or in others to resect a limited segment of the bowel containing the polyps but it not infrequently happens that the polypoid structures involve the entire mucosa of the colon and the rectum. In such cases the colon must be sacrificed. Palliation may be accomplished by excluding the colon by ileostomy, an offensive condition. It is attractive in such cases to remove the colon and to unite the ileum with the lower segment or rectosigmoid to preserve the natural avenue of discharge. He had undertaken such a procedure only once but unsuccessfully. The patient was a man aged forty-four, who had been subject to intestinal disturbances for several years. Three weeks before admission he had a very severe attack of diarrhœa, pain and bleeding from the bowels. The rectum and colon were seen to be full of polypi. The blood showed hæmoglobin, 53 per cent, red blood cells, 2,420,000, white blood cells, 9,800. His plan was (1) to make an ileostomy, (2) to remove the colon down to the lower sigmoid, (3) to make an ileo-sigmoidostomy to restore continuity, (4) to fulgurate away through the proctoscope and sigmoidoscope the papillomas of the lower bowel. The ileostomy was made satisfactorily and seventeen days later he removed the colon. In the light of this experience he now believed that a considerably longer interval should elapse between these two steps. There was no difficulty from the operative standpoint and the patient stood the operation well. During the operation the presence of large lymph glands in the lymphatic distribution of the colon and evidence of cellulitis of the retroperitoneal cellular tissue were evident. The patient did well enough for eight or nine days and then became distended, complained of pain and died on the fourteenth day of peritonitis. Autopsy showed no leakage from the bowel and it seemed to him that the infection came from the disturbed retroperitoneal tissues. Later Rankin reported several successful cases of this kind in which he had waited longer between stages. This operation is subject to modifications as in the case just reported but fundamentally it will consist in preliminary drainage of the bowel followed by removal of the whole or the affected part of the colon and by restoration of continuity.

As to the relationship of papillomata or polyps to the development of carcinoma a number of cases of simultaneous, independent carcinomas of the colon in association with polyposis are now on record. He had had no personal case of this sort but had had two cases of independent primary carcinomas of the rectum and sigmoid. In neither of these cases were polyps present in that portion of the colon and rectum which was removed. In his experience, polyps have been associated with carcinoma of the colon or rectum in more than 10 per cent of the cases. In a case of carcinoma of the rectum which has just left the hospital a large polyp gave considerable difficulty in establishing the function of the colostomy. After the bowel had been opened and the first escape of gas and liquid fæces had subsided, the patient continued to have colicky pains and the colostomy did not functionate properly. Finally, in about a week, she extruded a large globular polyp about three-quarters inch in diameter with a long pedicle attached just inside the opening. The resident removed it and there was no further trouble.

#### TRANSMANUBRIAL ENLARGEMENT OF UPPER THORACIC APERTURE FOR REMOVAL OF INTRATHORACIC GOITRE

DR EMIL GOETSCH (Brooklyn), reported the following case to illustrate the advantages of a transmanubrial division for the removal of a large intrathoracic goitre.

This patient was a woman aged fifty years, admitted to the Long Island College Hospital May 25, 1931.

About twelve years previous to admission, she began to have severe choking sensations and coughing spells. A mild enlargement of the neck first appeared on the right side of the neck four years later. At the same time the symptoms of pressure and hyperthyroidism became increasingly severe. Seven years later after a period of X-ray treatment, the enlargement diminished in size, with a period of comparative comfort. In November, 1929, symptoms of palpitation and dyspnoea became more severe. Occasional œdema of the legs was noted. She was in bed for five months and lost a great deal of weight. She also suffered fatigue and weakness and severe choking, more upon lying down. Shortly before admission she suffered with a cold which seems to have precipitated a crisis. Coughing, choking, dyspnoea and hoarseness became more severe, being almost constant. Loss of weight and weakness were progressive. X-ray examination of the chest showed a large mediastinal shadow, and the diagnosis of intrathoracic goitre was made.

The neck was broad and thick and showed a globular fullness low in the right anterior triangle just above the clavicle. The larynx and trachea were displaced to the left. Just above the clavicle on the right one could feel the dome of a firm, oval adenomatous mass which extended downwards into the mediastinum. The left thyroid lobe was slightly enlarged and irregular and tender but no nodules were found. A pulse was felt at the pole on the right but no thrill. No increased circulation was noted on the left. The percussion note over the manubrium and along its right margin was dull. Forced respiration produced a definite tracheal stridor. The voice was husky, low-pitched and very weak. A large, globular shadow occupied the right mediastinum, displacing the trachea to the left. The shadow was oval, circumscribed and about the size of a large orange. Examination of the lung fields was negative. The pulse was 100, the blood-pressure 148/80 and the

weight 156½ pounds Laboratory tests were negative The diagnosis was of intrathoracic goitre The patient was given pre-operatively Lugol's solution M VIII three times a day She was considerably benefited, the pulse coming down to 92

*Operation* April 27, 1931, anæsthesia of nitrous oxide, oxygen and a small amount of ether being employed The usual collar incision for the exposure of the thyroid was made The dome of the adenomatous mass on the right was uncovered This dome-shaped upper pole was the size of a small lemon and projected as it were upwards from the mediastinum It was dissected free from its attachments to the larynx and trachea in the usual manner Clamps were then placed on the capsule for the purpose of traction upon the intrathoracic mass The capsule, however, proved to be very thin and the dome of the tumor, being composed of friable nodules, fractured off from the main mass flush with the clavicle There was some bleeding at this point and it at once became evident that it was clearly impossible to raise the tumor through the available space in the thoracic aperture The trachea was displaced to the left and because of its compression against the upper margin of the manubrium there resulted increasing respiratory difficulty when an attempt was made to raise or dislocate the intrathoracic mass The latter had assumed the shape of a pear, produced by compression of the clavicle and the first rib By far the larger part of the mass was in the mediastinum below the groove produced by the clavicle and first rib

In order to gain more space, the manubrium was exposed by a vertical incision downward from the centre of the collar incision The fascia and tissue of the jugular notch was carefully freed from the manubrium A finger was inserted behind the manubrium to free its posterior surface of blood-vessels, fascia and possibly pleura Two perforator-burr trephine openings were made in the body of the manubrium Through these in turn and over the upper margin of the manubrium a Gigli saw was inserted and by this means a vertical division of the manubrium was readily performed By means of retractors and with fair ease the two halves of the manubrium were then separated until a gap of about an inch or more was obtained This gave a striking increase in size of the thoracic aperture and the mediastinal mass was then surprisingly readily brought up into the neck It was the size of a grape fruit, oval in shape and showed the grooving of the clavicle and first rib The mass was encapsulated and composed of colloid nodules, many of which showed old fibrous change but no calcification There was complete atrophy of the former right thyroid lobe The right recurrent nerve was exposed during the dissection The isthmus and left lobe were practically normal in size and appearance A small gauze pack was placed immediately in front of and behind the manubrium and another in the mediastinal cavity The two halves of the manubrium were brought together by chromic cat-gut sutures of the periosteum and the fascia at the upper border of the manubrium Throughout there was no great difficulty with respirations and the condition of the patient at the end was good

In the evening of the day of operation, the patient's speech was definitely better than before operation The drains and gauze pack were removed within the first forty-eight hours On the third day following operation, there was some cough and expectoration which soon cleared up During the following two days, the patient complained of some pain in the region of the manubrium This was not severe, however The wound healed normally and on the tenth day a check-up of symptoms revealed that all choking, cough, dyspnœa, palpitation and nervousness had disappeared

She was discharged two weeks after operation in excellent condition. Nearly two years later, when seen on February 8, 1933, she stated that she had been entirely well since leaving the hospital. She had gained considerably in weight, five pounds over her previously greatest weight. The voice was clear, the so-called asthmatic attacks were entirely relieved as also the previous symptoms of hyperthyroidism. There were no symptoms referable to the division of the manubrium.

Doctor Goetsch stated that he had found no reference to a similar operation for the removal of large intrathoracic goitre which cannot be brought up through the thoracic aperture in the usual manner. It is rarely necessary to resort to this measure, but, as in this case reported, the procedure described became imperative.

Kerr and Warfield\* described an operation based on much the same principles, namely, the vertical division of the manubrium and sternum, with raising one-half of the divided sternum and attached ribs, for the exposure and removal of an intrathoracic dermoid.

DR GEORGE P. MULLER said that as a rule intrathoracic goitre can be removed by simple luxation and excision. As these goitres almost always maintain their blood supply from above, the inferior thyroid should be ligated first. Sometimes alarming hæmorrhage results from the tearing of veins going to the surrounding fascia and hence luxation should not be attempted where much force is necessary to elevate the mass. He had removed the tumor by morcellement several times but this is an untidy operation. In a few cases he had cut away the top of the sternum with rongeur forceps in order to get room for the luxation, and had found this very satisfactory.

Resection of the manubrium and anterior mediastinotomy should find its greatest use in those cases of intrathoracic goitre when the diagnosis from tumors such as dermoids is difficult and where the goitre practically has no connection with the lower pole or isthmus. In this procedure as well as in the luxation of tightly wedged tumors anæsthesia is greatly facilitated by bronchoscopic control.

As illustrative of a typical case he cited the history of a man aged forty-two, who was admitted to the University Hospital, December 14, 1931, on account of dyspnœa and cough which had persisted for three months. Röntgen-ray examination showed a tumor about the size of a lemon behind the right second rib. In October he was given ten deep X-ray treatments over a period of three weeks but because of increasing severity of cough operation was finally decided upon. It was noted that when the patient coughed there was a definite bulging of the lower neck. The basal metabolic rate was plus 15. There was a slight tremor but no tachycardia, the thyroid gland was just palpable but the lower poles apparently could be identified. An electrocardiogram showed frequent ventricular extra systoles, but was otherwise negative.

Fluoroscopical and film examination showed a tumor in the anterior mediastinum displacing the trachea to the left, and posteriorly. Swallowing changed the conformation of the tumor and this is considered an important differential point from aneurism. December 17, 1931, under ether anæsthesia and with a bronchoscope introduced to the bifurcation, usual exposure for

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\* Kerr and Warfield Trans Amer Surg Assn, vol XLVI, pp 291-313, 1928

thyroidectomy was done by a low transverse incision. The tumor could be felt but could not be budged nor could the finger be introduced below it. Therefore a T-incision was made, the sternum split to the second rib and outwards to the left and the incision spread. The tumor could then be dislocated upwards and outwards. A pedicle was found prolonged from the right lower pole. This was divided and the mass removed. The parts of the sternum were brought together by an encircling chromic catgut. Two large cigarette drains were placed in the cavity. The patient breathed easily throughout the operation. The specimen measured 9 by 8 by 4.5 centimetres and was a thyroid adenoma (non-toxic).

The patient seemed to be making an uninterrupted recovery when on December 28, the Röntgen-ray disclosed a large shadow equivalent to the shadow of the tumor. This was thought to be a hematoma. Laryngoscopy showed no evidence of tracheal compression, nor interference with phonation. The subsequent course of events justified the diagnosis of a hematoma because a bloody serous fluid discharged until March, 1932, at which time the wound was healed. On November 17, 1932, he was perfectly well and driving a wagon.

A few months prior to the operation on this patient Doctor Muller had attempted to remove a large intrathoracic goitre which was located in the posterior mediastinum after a trans-sternal mediastinotomy. Considerable manipulation was done but the mass could not be brought up and the operation was abandoned. The patient died.

In the average case the exposure suffices to enable the surgeon to dislocate the tumor and if care is taken to prevent tearing of the pleura there should be no serious complications. The cut surfaces of the sternum bleed freely. His experience justified the statement that large intrathoracic goitres with marked tracheal deviation justify the routine use of anaesthesia through the bronchoscope.

# BRIEF COMMUNICATIONS

## UNILATERAL FUSED KIDNEY

AN ADULT, male, was admitted to the Asbury Hospital of Minneapolis, Minnesota, September 20, 1931, complaining of pain in the back and right side with nausea and vomiting, temperature,  $100.3^{\circ}$ . Examination revealed a mass as large as a grapefruit in the upper right quadrant of the abdomen, cystoscopical examination showed a normal bladder, normal flow of urine through left ureter, unusual rapidity of flow through right ureter for a time and then final cessation. X-ray showed both ureters passing to right side of body, Skiagraphs revealed great dilatation of right kidney pelvis, a partially filled kidney pelvis at level of fourth lumbar vertebra, inclined toward the right, no kidney shadow in its normal place on the left side. Catheterized specimens from right and left ureters showed total function of elimination maintained entirely by left kidney. Urine contained abundant red cells and pus cells. *Diagnosis*—Right unilateral fused kidney, pyonephrosis and calculus of upper right kidney.

*Operation*—September 21, 1931. Dr B. A. Gingold, consultant. Kidney mass exposed by lumbar incision on right side, a mass the size of a football presented, consisting of the two kidneys fused (Fig 1), upper kidney had a pelvic sac fifteen to eighteen centimetres in diameter attached to a kidney about 7.5 centimetres in diameter, the lower kidney was about two-thirds of the total kidney substance and had a normal pelvis. The sac was opened and removed with the intention of exposing the blood-vessels of the pedicle. This procedure was attended with such bleeding from the upper pedicle that after control had been established by ligation, it was thought best to postpone further surgery. Reaction was slow, with pulse of 168 and temperature of  $105^{\circ}$ . Catheterization was required every eight hours, patient became uncontrollable from bladder strangury which was relieved by cystostomy done on the fourth post-operative day. From that time his progress was uneventful. Urine continued to drain through the lumbar incision.

Two weeks later, the patient apparently restored to normal condition, a second operation was instituted. In the perirenal space, multiple pus pockets were opened into, line of demarcation between the upper and lower kidney was very clearly seen, the pedicle of the upper kidney was divided and the upper kidney sectioned from the lower kidney, hæmorrhage prevented by the placing of an intestinal clamp, hæmostasis imperfect, patient became pulseless, demanding cessation of the operation and active efforts to stimulation, the man slowly reacted and during the next twenty-four hours was transfused twice. Further stimulus supplied by proctoclysis, venoclysis and hypodermoclysis. Under this treatment he gradually recovered his strength. On October 18, two weeks after the second operation, while asleep, a secondary hæmorrhage started, requiring, after ineffectual primary effort at hæmostasis, re-opening of the wound and exposure of the kidney bed. Wound was packed with iodoform gauze with apparent stopping of hæmorrhage. Transfusion was again done. For some days his condition remained critical during which time repeated bleedings and transfusions characterized the case. He gradually succumbed and died October 25, 1931.

Fig 1 represents the composite of the findings at operation and post-mortem. Microscopical examination of the kidney structure showed fibrosed glomeruli, numerous hyalinized tubules with some areas of lymphocytic infiltration.

Up to 1930, 111 of these anomalies have been reported in the literature, the majority drawn from autopsy material. Albarren, in 1909, was the first

## UNILATERAL FUSED KIDNEY

to diagnose this anomaly pre-operatively by introducing the then newly devised opaque catheters. Of these cases twenty-three have been operated upon. Four of them were done before the anomaly was recognized, with complete removal of the entire mass, resulting in death from anuria, thirteen were of

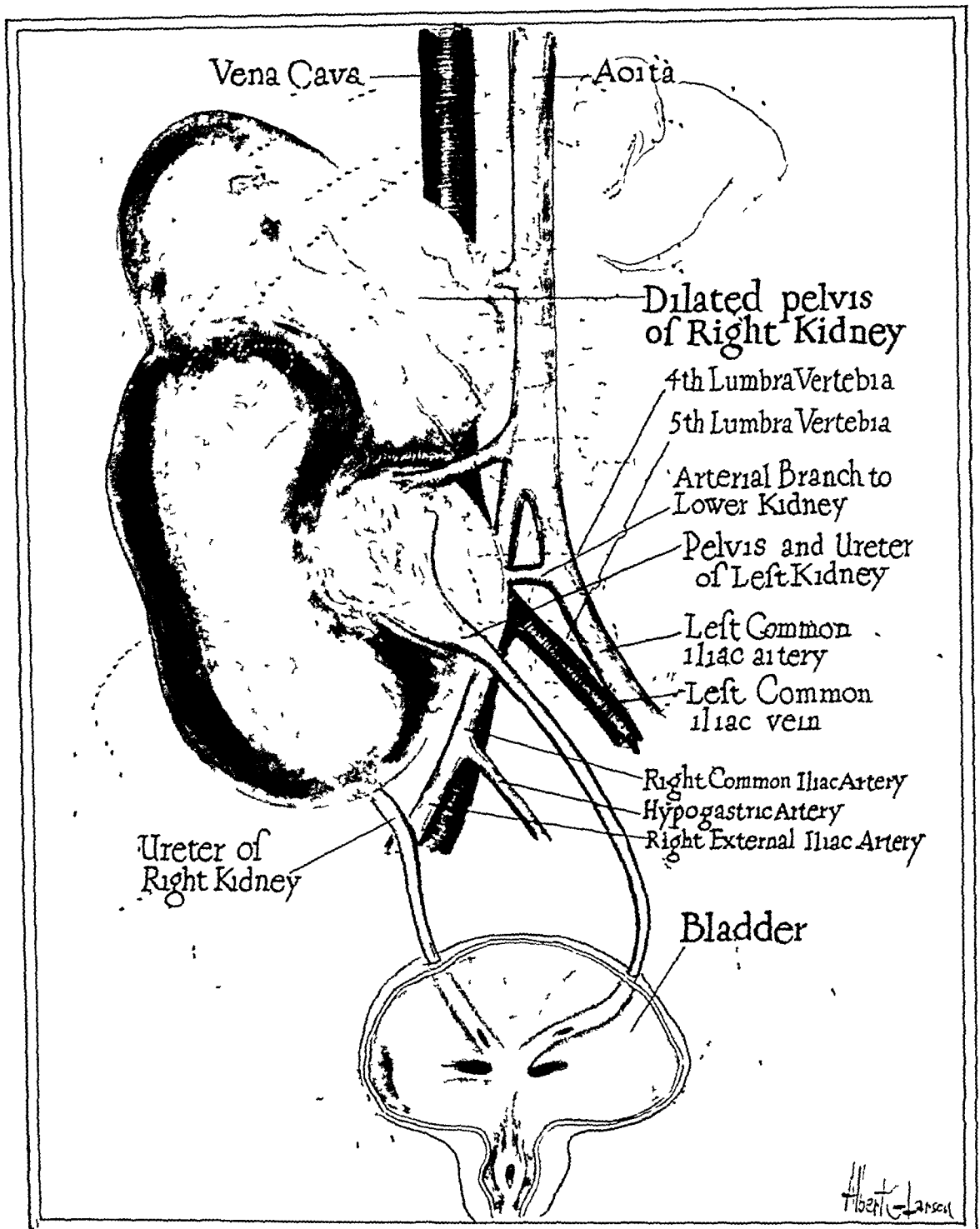


FIG 1

palliative nature for drainage, removal of a calculus, suspension of the kidney, or attempts at replacement, six have been associated with resection of one kidney, in two the upper, in four the lower half, all of them have dealt with the ectopic kidney as the diseased organ. This is the only case treated surgi-



cally in which the normally placed kidney has been the damaged portion. Also this is the only surgical death reported since 1909. Variations in this case from the normal were many anomalous vessels and nerves. The ureters were normally placed in the bladder, but the ureter of the upper kidney passed behind the mass, whereas it usually is placed in front. The lower ectopic kidney was rotated  $45^\circ$  to empty anteriorly, while the upper, as is customary, secreted toward the medial margin. The vessels entered the kidney substance posteriorly to the mass. The anomalous placement of the vena cava, also the difference of the aorta of the left renal artery, are well shown in the drawing.

This kidney anomaly is more common in men than in women, and usually causes trouble during the third decade of life. Young patients are more troubled with hydronephrosis, the older patients with pyonephrosis. In this case, the microscopical findings in the urine demonstrated that the infection had invaded the entire mass right from the start. Usually the transposed portion of the kidney is infected, in this case the normally placed organ was the one diseased.

The ideal treatment should be. First, ureteral drainage with later surgery. Failing in this, second, pyelostomy or nephrostomy with later surgery. This man should unquestionably have survived, had the infection been of milder nature, or his physical reserve less exhausted at the time of the onset of his illness. Both the post-operative hæmorrhages (delayed), and the terminal uræmia were results of the infection. A careful consideration of post-operative nephritis would be the only final resource.

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#### CONGENITAL ABSENCE OF VERMIFORM APPENDIX

THIS case is reported because of the rarity of this developmental anomaly and the misleading clinical picture presented by the patient. W. H., white, male, aged forty-one years, was admitted to hospital August 7, 1932, at 9:30 A.M. About 11 P.M. the day before admission he had been suddenly seized with generalized abdominal pains which became aggravated after a dose of castor oil. Nausea and vomiting ensued. The pain continued throughout the night.

On admission, ten and one-half hours after onset, he complained of abdominal pain, particularly in right lower quadrant, general malaise, marked anorexia, but no nausea or vomiting. The respiratory, genito-urinary, cardiovascular and nervous systems were negative. Abdomen showed marked tenderness in right lower quadrant with some spasm of the right rectus muscle. Temperature,  $99.4^\circ$ , pulse, 84, respirations, 22. White

## CONGENITAL ABSENCE OF VERMIFORM APPENDIX

blood-cells, 12,800, with 91 per cent polymorphonuclears, 3 per cent transitionals and 6 per cent lymphocytes. Urine, negative.

Under a diagnosis of acute appendicitis, the abdomen was opened through a right rectus muscle-splitting incision. The serosa of the small intestine was reddened and an increased amount of peritoneal fluid was present. The cæcum was delivered and inspection of the entire region made but no appendix could be identified. The cæcum was then liberated by cutting the lateral peritoneal attachment to bring into view the retrocecal area without identifying the appendix. During this procedure three large blood-vessels were cut and ligated. At the time it was feared that the cecal blood supply was thereby impaired. A general exploration of the peritoneal cavity revealed no other pathology. The wound was closed without drainage.

After the operation the temperature rose to 102° F and pulse to 115 during the first twenty-four hours. Subsequently the temperature varied between 100° and 103° F and the pulse rate between 85 and 100 until the day of death. Abdominal distention developed early and persisted in spite of treatment (rectal tubes, gastric lavages and, later, various types of enemata and pituitrin). Dynamic ileus was diagnosed. From this time continued vomiting necessitated leaving a Levine tube continuously in place.

At 7 P M, five days post-operative, he had sudden intense abdominal pain with a temperature drop, pulse rise, cold and moist skin, increased abdominal distention and generalized tenderness. Immediate laparotomy revealed a marked generalized peritonitis with fecal fluid free in the peritoneal cavity. An ileostomy was rapidly performed but the patient became progressively worse and died at 2 10 A M the next day—one week after onset of illness.

*Surgical Comment*—Due to the fact that the appendix was not found intraperitoneal, we were too intent on trying to find a retroperitoneal appendix and by the intensive search damaged the blood supply to the ileocecal region with fatal results.

Autopsy demonstrated gangrene of the cæcum and ascending colon and in their walls three perforations, one to two centimetres in diameter. Within the corresponding mesentery there are several ligated blood-vessels. Thorough examination of the ileum, cæcum and ascending colon fails to reveal any evidence of the appendix. The terminal twelve inches of the ileum, the cæcum and the ascending colon with a large part of their mesenteries were removed in one piece and placed in fixing solution and later carefully studied in detail. The anterior tenia was followed to its termination, at which point the cæcum was smooth. The point of junction of the three teniæ was thoroughly examined. Not even a rudimentary projection to indicate the site of the appendix could be found. The serosal surface of the cæcum was everywhere smooth except for the site of the exudate and perforations. The mucosal surface was devoid of any dimpling which might suggest the orifice of the appendix. Numerous and practically serial sections were taken from the site of junction of the tenia and from immediately below the ileocecal valve. Histological examination has failed to reveal any tissue suggestive of appendix. Subsequently additional blocks of tissue were taken with the cooperation of the operating surgeon and they also proved negative for appendiceal tissue.

*Comment*—The incidence of agenesis of the vermiform appendix, first recorded by Morgagni,<sup>1</sup> in 1719, has been thoroughly reviewed in the last two years by Bradley<sup>2</sup> and Spivak,<sup>3</sup> who added three cases to bring the total reported number to forty-six. Since the latter's article (submitted in December, 1930), no record of additional cases of this anomaly has been found. The same author mentions the fact that several of the cases reported are from unreliable sources, that some represent merely hypoplasia of the organ, and that the exact number of cases of true agenesis could be reduced

## BRIEF COMMUNICATIONS

to about twenty-five Bearing on the first fact, recently Dr John F Erdmann experienced difficulty in identifying the appendix and then remarked that he had never witnessed at the operating table an agenesis of the appendix and that he could readily understand the erroneous reporting of such ageneses by less experienced surgeons In this connection we may mention a resected cæcum recently received in this laboratory with the clinical diagnosis of probable malignancy In this case the pathologist identified the appendix only after prolonged and careful examination We cite these instances to stress the point that a true agenesis is very difficult to establish with certainty at the operating table because sufficiently thorough examination of the cecal area is not practical—even if possible—at that time

Critically considering such possibly incorrect reports, some of which will never be verified, and since the number of cases of each type will increase in proportion to the number of post-mortem examinations, it seems proper that a distinction be made between hypoplasia and congenital absence or agenesis of the appendix In agreement with Spivak, we suggest that the number of reported cases of such agenesis be set arbitrarily at twenty-five, to which is added our case

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## DIVERTICULUM OF THE GALL-BLADDER

ANOMALIES of the gall-bladder are rare, and but very few references to such cases can be found in the literature An anomalous gall-bladder of this type and complication has never been reported

The reported cases are Kremer,<sup>1</sup> Cholecystography in Diverticulum, Csillag,<sup>2</sup> Diverticulum of Gall-bladder, Barsony, T, and Friedrich,<sup>3</sup> Three Cases of Diverticulum of Gall-bladder, Sebening and Schondube,<sup>4</sup> Large Diverticulum of Gall-bladder, with Stenosis of Pylorus, Abbott,<sup>5</sup> Diverticulitis of Gall-bladder, in this case the diverticulum was near the fundus, no stones present nor was the gall-bladder highly pathological, Nadeau, O,<sup>6</sup> Diverticulum of the Gall-bladder, this was undoubtedly a congenital anomaly, for there was no evidence of severe inflammation nor injury found in this region, Ross,<sup>7</sup> Pseudo-diverticulum of Gall-bladder, near the fundus a pouch was located which was examined microscopically and proved that only one side of the pouch thought to be that which corresponds with the interior of the gall-bladder proper No such appearance was seen on the opposite side, so from these finds, as well as from the gross appearance, the pouch was not

## DIVERTICULUM OF THE GALL-BLADDER

congenital, but rather an acquired type, Michalski,<sup>8</sup> Diverticulum of the Gall-bladder, Kammerer,<sup>9</sup> Diverticulum of the Gall-bladder

The case that I am about to report was not examined microscopically, so I cannot say definitely if it is or is not a congenital pouch. But at the time of operation the communication between the pouch and the gall-bladder proper was only one mm

*Case*—Mrs R, a young married woman of twenty-seven years of age, had always been well before her marriage in 1927. Her weight at the time, 140 pounds, had gradually increased to 150 pounds during the three years following. In 1929, she noticed distress

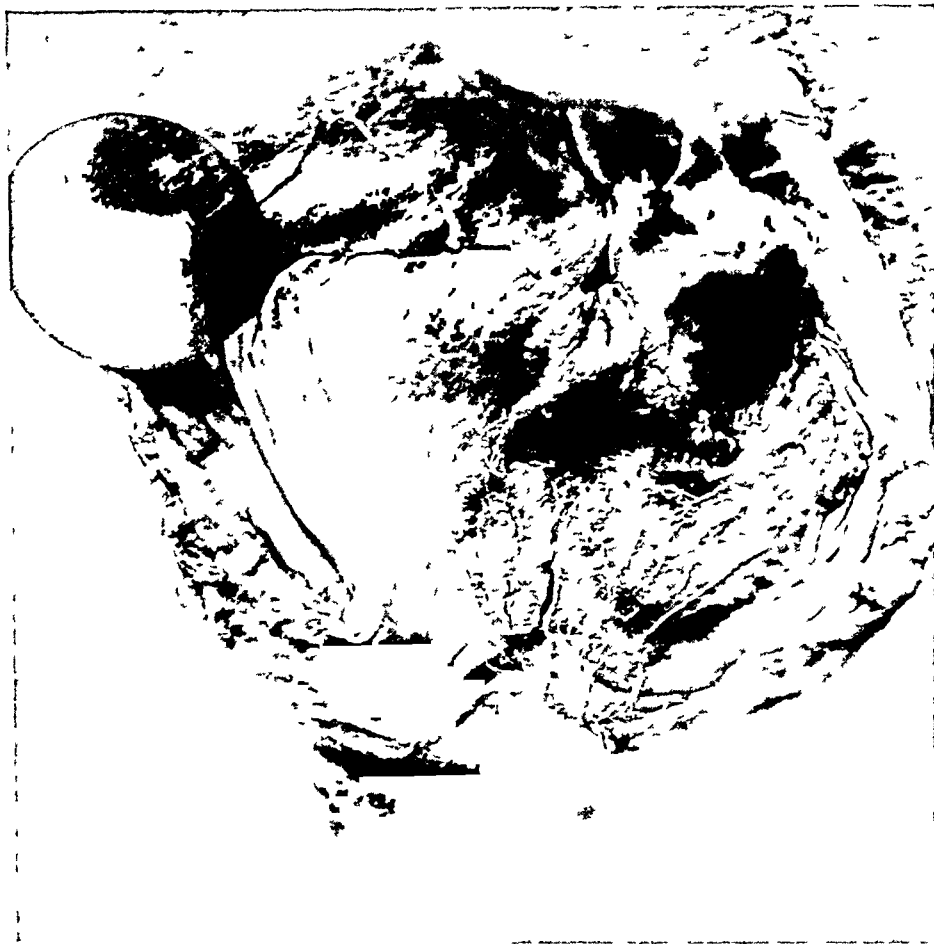


FIG 1—Diverticulum of gall bladder

after eating oranges but no other foods gave trouble. During her first pregnancy, in August, 1930, she suffered much from nausea, vomiting and belching during the entire period of gestation. Seven days after delivery, in June, 1931, she suffered a severe attack of belching, nausea and pain throughout the entire right abdomen and extending through to the right scapular region. Similar attacks of variable duration and severity recurred thereafter following extreme fatigue, or eating fatty foods, pastry or meats. In July, 1932, she complained of constipation. At this time she was slightly jaundiced. Late in October she had an attack of severe abdominal pain extending through to the back on the right with vomiting and nervousness. Temperature, pulse, and respirations were normal. After the pain had been present for a week and had been gradually getting worse she was taken to the hospital, where, under treatment, temporary relief was obtained. After two weeks the abdominal symptoms returned as before and operation was decided upon. An upper right-rectus incision was made. Upon opening the abdomen

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a few adhesions in the region of the gall-bladder and liver were found, the tip of the gall-bladder was adherent to the jejunum, when freed, a diverticulum of the gall-bladder was found which had perforated the wall of the bowel (Fig 1) The opening in the bowel was sutured Upon further inspection the gall-bladder was found to be slightly thicker and more congested than normal In the cystic duct was a stone three-quarters of an inch in diameter This was milked back into the bladder before the duct was tied and the gall-bladder removed The appendix appeared to be subacutely inflamed and was therefore removed Drain was inserted lateral to the incision and wound closed in layers, recovery was uneventful

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## ADDENDA

July, 1933, issue

Page 1 last sentence to first paragraph should read "The surgery was performed chiefly by Dr Harvey Righter and the author and their assistants"

Page 16, before Bibliography, paragraph to read "I wish to thank Dr Edward S Dillon, Chief of the Metabolic Division at the Philadelphia General Hospital for his courtesy in allowing me to use the valuable records and material from his department as well as for his review of the manuscript Thanks are also due his staff, especially Dr Sidney Weinstein, for their assistance in rendering this data available"

June, 1933, issue

Page 949, on thirteenth line from bottom the name Bennett should read, Benedict (Edward B)

## EDITORIAL ADDRESS

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# ANNALS *of* SURGERY

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## GALL-BLADDER SURGERY

A REPORT OF TWO HUNDRED CONSECUTIVE OPERATED CASES OF GALL-BLADDER DISEASE \*

BY WILLIAM T DORAN, M D , KENNETH M LEWIS, M D , EDWARD V DENNEEN, M D , AND EILIF C HANSSEN, M D

OF NEW YORK, N Y

FROM THE GALL-BLADDER CLINIC, FOURTH SURGICAL DIVISION OF BELLEVUE HOSPITAL

THIS paper is a report of 200 consecutive cases of gall-bladder disease operated upon in the wards of the Fourth Surgical Division of Bellevue Hospital from July 1, 1927, to July 1, 1932. These cases have been studied pre-operatively and followed post-operatively in a special gall-bladder clinic conducted by the authors.

We first take a careful history, inquiring about pain and its characteristics, nausea, vomiting, distention, belching, jaundice, fever and chills, *etc*. If a gall-bladder operation has been performed, careful inquiry is made as to whether the gall-bladder was removed and if stones were found. Then the patient is given a complete physical examination and a special effort is made to locate foci of infection. A urinalysis, blood Wassermann and cholecystogram are ordered and the patient is requested to return one week later for biliary drainage.

X-ray examination in the form of the Graham test was done on 126 patients. Due to the large number of patients that the X-ray department of Bellevue Hospital has to handle each day, it was not feasible to have the dye administered intravenously. For this reason the dye was administered by mouth.

The preparation of the patient and the technic of the X-ray examination were as follows:

(1) Cathartic at bedtime two days previous to examination.

(2) Light diet the following day with evening meal at 6 30 P M. Dye administered at 10 P M. No food or water after 10 P M until patient has reported for first examination in X-ray department at 9 30 A M the next morning.

(3) First radiograph is made at 9 30 A M. If the gall-bladder is filled and is visualized, patient is instructed to eat a fatty meal and return to X-ray department for further examination in one hour. If not visualized patient is re-examined without fatty meal in one hour.

(4) Third examination is made the following morning.

(5) Exposure (average patient) 65 K V P, 100 ma for three seconds. Film target distance twenty-five inches, using Buckey diaphragm.

\* Read before the Society of Alumni of Bellevue Hospital, February, 1933.

Of the 126 cases X-rayed the results were as follows:

*Gall-bladder Did Not Visualize*—Ninety cases Of these, seventy-two showed cholelithiasis, or a combination of cholelithiasis and chronic cholecystitis, proven by operative findings and pathological examination Eighteen cases showed a normal gall-bladder at operation, except for two cases which showed definite adhesions to surrounding structures but no other pathology, and one case which was densely adherent to a carcinoma of the stomach

*Gall-bladder Did Visualize—filled and emptied normally and did not show any shadows of calculi*—Twenty-nine cases Of these, sixteen had cholelithiasis with chronic cholecystitis at operation, ten cases had a normal gall-bladder, one case had a carcinoma of the stomach, one case had a cirrhosis of the liver, one case had a carcinoma of the head of the pancreas

*Gall-bladder Did Visualize—and shadows suggestive of calculi were present*—Five cases Of these, four patients had cholelithiasis at operation and one patient had a normal gall-bladder with no stones

*Gall-bladder Did Visualize—but showed delayed emptying, suggestive of pathology*—Two cases Of these, one patient had a cholelithiasis and one patient had an atrophic sclerotic gall-bladder with adhesions, evidently the site of a previous inflammatory process

The above observations may be summarized as follows

*Gall-bladder Did Not Visualize*—Ninety cases Seventy-two cases showed definite gall-bladder pathology

*Gall-bladder Did Visualize and Appeared Normal in the X-rays*—Twenty-nine cases Thirteen cases showed no pathology of gall-bladder

*Gall-bladder Did Visualize but Showed Shadows of Calculi*—Five cases Four cases showed calculi at operation

*Gall-bladder Did Visualize but Showed Delayed Emptying*—Two cases Two cases showed gall-bladder pathology at operation

*Total of 126 Cases*—of which ninety-one cases confirmed X-ray findings at operation

It can thus be seen that the X-ray findings were correct in 72.2 per cent of the cases examined

In analyzing these findings from the standpoint of the two main groups of cases, *i.e.*, those in which the gall-bladder visualized and those in which the gall-bladder did not visualize, we note the following

*Gall-bladder Did Not Visualize (or Visualized but Showed Calculi or Delayed Emptying)*—Ninety-seven cases Seventy-eight cases showed definite pathology The X-ray findings were confirmed in 80.4 per cent of the cases examined

*Gall-bladder Did Visualize and Appeared Normal in the X-rays*—Twenty-nine cases Thirteen cases showed no pathology The X-ray findings here were confirmed in 44.8 per cent of the cases examined

It can thus be seen from the above that the greater margin of error lay in those cases which visualized a normal gall-bladder at X-ray examination This is readily understandable when one considers that a few small calculi

may be present in a gall-bladder without obstructing the cystic duct, and at the same time the calculi may be so small that visualization in an X-ray would be difficult or impossible

It would seem then as though one were safe in saying that, given a patient with a suggestive history of gall-bladder disease and a non-visualization of the gall-bladder by X-ray, after the administration of dye, the likelihood of finding gall-bladder pathology at operation was most probable. On the other hand, a patient with a similar history in whom the gall-bladder visualizes normally cannot be considered free from gall-bladder pathology merely on the X-ray findings

Recently we have added biliary drainage to our diagnostic measures, and are reporting herewith a series of fifty-six operated cases in whom pre-operative biliary drainages were performed

The purpose of this procedure is to procure specimens of bile from the different parts of the biliary tract by means of a duodenal tube. The technic is simple and is usually accomplished within two hours. Any of the standard duodenal tubes may be used. We have been using the Twiss tube with excellent results

With a normally functioning biliary tract, the drainage produces a free flow of golden-yellow bile. Following stimulation with magnesium sulphate solution or olive oil one to two ounces of concentrated olive-green bile are obtained. With a partial or complete obstruction of the cystic duct there is usually a diminished quantity or an absence of concentrated bile. Whenever possible a drainage showing an absence of concentrated bile should be repeated

Partial obstruction of the common duct usually allows sufficient bile to enter the duodenum to permit removal of a sample for microscopical diagnosis. Complete obstruction of the common duct prevents the entrance of bile into the duodenum and hence the drainage specimens will show no bile

Lyon, Bockus and others have called attention to the fact that the presence of certain microscopical elements in the bile is suggestive of cholelithiasis

Bockus states his conclusions as follows: "Non-surgical biliary drainage is an examination of paramount importance in the positive diagnosis of gall-stones. One hundred and twenty-four patients, in whom cholesterol crystals or bilirubin calcium pigment were recovered from the bile pre-operatively, have been subjected to operation. Finding these two elements in the same bile is pathognomonic of cholelithiasis (seventy-two cases). Cholesterol crystals without the characteristic pigment (eighteen cases) is 89 per cent accurate, and bilirubin calcium pigment (thirty-four cases) 90 per cent accurate in gall-stone diagnosis."

In analyzing our series we shall first call attention to the frequency with which cholesterol crystals or bilirubin calcium pigment were present in the pre-operative drainage bile, and then we shall discuss that group of cases in which gall-stones were found



With a few exceptions, a single drainage was done in each case. A careful examination of all bile specimens was made for pathological elements. Following is an analysis of the microscopical and operative findings.

Out of fifty-six cases drained prior to operation, cholesterol crystals or bilirubin calcium pigment or both of these elements were present in the bile in twenty-six cases. At operation stones were present in twenty-five cases (96 per cent). A further analysis of these twenty-six cases showed that cholesterol crystals without bilirubin calcium pigment were present in fifteen cases. Operation revealed stones in every case (100 per cent). Bilirubin calcium pigment without cholesterol crystals was recovered in the pre-operative drainage bile in four cases. At operation stones were present in every case (100 per cent). Both cholesterol crystals and bilirubin calcium pigment were present in the bile obtained by drainage in seven cases. At operation calculi were found in six cases (85 per cent). The one case in which stones were not found at operation showed considerable gall-bladder "sand" in the pre-operative drainage bile.\*

Out of the fifty-six cases studied, forty showed cholelithiasis at operation. In these forty cases, pathological drainage findings, namely, the presence of either cholesterol crystals or bilirubin calcium pigment or both, or the absence of concentrated bile, resulted in thirty-six cases (90 per cent). The remaining four cases of cholelithiasis showed a normal biliary drainage.

The pathological drainage findings in the thirty-six cases just mentioned were as follows. In twenty-five cases (62.5 per cent) either cholesterol crystals or bilirubin calcium pigment, or both of these elements were recovered in the pre-operative drainage bile. The remaining eleven cases (27 per cent) showed no crystals or pigment but revealed an absence of concentrated bile.

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\* This case which showed no calculi at operation but cholesterol crystals and bilirubin calcium pigment in the pre-operative drainage bile is of special interest and merits further comment. At operation which was performed several weeks after the second drainage, the findings were an atrophic gall-bladder without stones and a normally functioning cystic duct. Keeping in mind the statement of Bockus that the finding of cholesterol crystals and bilirubin calcium pigment in the same bile is pathognomonic of gall-stones, it would seem that the case in question does not substantiate Bockus' contention. However, if Bockus includes gall-bladder "sand" in his definition of gall-stones, this case may well illustrate his point. Two drainages were performed in this case. The first drainage produced no concentrated bile, and showed on microscopical examination occasional clumps of bilirubin calcium pigment. A second drainage performed two days later showed a large amount of dark brown concentrated bile which contained ten to fifteen cubic centimetres of a fine light brown sediment or "sand" such as we find in gall-bladders at operation. Microscopical examination of this sediment showed many cholesterol crystals and many small clumps of bilirubin calcium pigment.

In this case, the second drainage probably completely emptied the gall-bladder of its "sand," and with the re-establishment of the patency of the cystic duct, no further "sand" accumulated in the gall-bladder between the time of the second drainage and the time of the operation.

# GALL-BLADDER SURGERY

## ANALYSIS OF 56 CONSECUTIVE OPERATED CASES WITH PRE-OPERATIVE BILIARY DRAINAGE AND RONTGENOLOGICAL FINDINGS

		Concentrated Bile	Microscopical Findings	X-ray with Dye	Findings at Operation
1	S A	o	Cholesterol	OV*	Calculi Chronic cholecystitis
2	A B	+	Cholesterol	NV* Calculi*	Calculi Contracted gall-gladder
3	N C	+	Negative	NV	Strawberry gall-bladder
4	J B	+	Negative		Calculi Thickened gall-bladder
5	B H	+	Cholesterol	NV	Calculi Chronic cholecystitis
6	J E	o	Negative	OV	Calculi Dilated gall-bladder
7	S I	o	Negative	NV	Calculi Dilated gall-bladder
8	D J	+	Negative	NV	Chronic cholecystitis
9	E K	+	Negative		Calculi Chronic cholecystitis
10	K K	o	Cholesterol		Calculi Contracted gall-bladder
11	E K	o	Cholesterol	Calculi	Calculi Chronic cholecystitis
12	M M	+	Cholesterol Bilirubin Ca	OV	Calculi Strawberry gall-bladder
13	E N	+	Negative	FV*	Calculi Chronic cholecystitis
14	M P	o	Negative	NV	Chronic cholecystitis
15	M S	+	Cholesterol	Calculi	Calculi Contracted gall-bladder
16	A T	o	Cholesterol	OV	Calculi Chronic Cholecystitis
17	K O	o	Negative	FV	Calculi Atrophy of gall-bladder
18	B O	o	Negative	NV	Strawberry gall-bladder
19	A R	+	Negative	FV	Chronic cholecystitis
20	H R	+	Bilirubin Ca	OV	Calculi
21	M S	o	Cholesterol Bilirubin Ca	OV	Calculi
22	O A	o	Cholesterol	OV	Calculi
23	Z A	o	Negative	FV	Normal gall-bladder Cirrhosis of liver
24	A T	o	Negative	OV	Calculi
25	R	o	Cholesterol Bilirubin Ca	NV	Calculi
26	H N	+	Cholesterol Bilirubin Ca	NVDE Calculi	Calculi
27	A T	o	Bilirubin Ca	OV	Calculi
28	J C	o	Negative	OV	Chronic cholecystitis
29	W P	(1) o	Bilirubin Ca	OV	
		(2) +	Cholesterol Bilirubin Ca		Atrophic gall-bladder

# DORAN, LEWIS, DENNEEN AND HANSSEN

## ANALYSIS OF 56 CONSECUTIVE OPERATED CASES WITH PRE-OPERATIVE BILIARY DRAINAGE AND RONTGENOLOGICAL FINDINGS (*Concluded*)

	Concentrated Bile	Microscopical Findings	X-ray with Dye	Findings at Operation
30 L S	o	Cholesterol Bilirubin Ca	OV	Calculi
31 A R	o	Negative	OV	Normal gall-bladder Cirrhosis of liver
32 A M	o	Negative	OV	Calculi
33 P	+	Negative		Chronic cholecystitis
34 H	o	Negative		Calculi
35 A	o	Cholesterol		Calculi
36 K V	+	Cholesterol	OV	Calculi
37 S S	+	Negative		Chronic cholecystitis
38 C Q	o	Negative	OV	Atrophic gall-bladder
39 E P	o	Bilirubin Ca	OV	Calculi
40 G M	o	Cholesterol	OV	Calculi
41 J K	o	Cholesterol Bilirubin Ca	OV	Calculi Atrophic gall-bladder
42 M K	o	Negative	OV	Calculi
43 S G	o	Negative	OV	Calculi
44 G F	+	Negative	OV	Calculi
45 M F	o	Negative	NVDE	Calculi
46 A D	o	Negative	OV	Chronic cholecystitis Small fibrotic gall-bladder
47 M D	o	Negative	OV	Chronic cholecystitis
48 M C	o	Negative	FV	Atrophic gall-bladder
49 F C	o	Negative	FV	Calculi
50 S B	o	Bilirubin Ca	OV	Calculi
51 P B	o	Cholesterol		Calculi Gangrene of gall-bladder
52 J A	o	Negative	OV	Calculi Chronic cholecystitis
53 A A	+	Cholesterol	OV	Calculi Atrophic gall-bladder
54 M H	+	Cholesterol	OV	Calculi Atrophic gall-bladder
55 E D	+	Cholesterol	OV	Calculi Chronic cholecystitis
56 M B	o	Negative	OV	Acute cholecystitis

\* NV—Normal visualization of gall-bladder

OV—No visualization of gall-bladder

FV—Faint visualization

DE—Delayed emptying

Calculi—Shadows resembling calculi seen in röntgenogram

*Summary*—(1) An analysis is presented of the pre-operative diagnostic biliary drainage findings and operative findings in fifty-six cases of biliary tract disease

(2) Cholesterol crystals or bilirubin calcium pigment or both were found in the pre-operative biliary drainage bile in twenty-six cases. Calculi were found at operation in twenty-five of these cases. The one case in which

## GALL-BLADDER SURGERY

stones were not found showed gall-bladder "sand" in the drainage bile (96-100 per cent correct stone diagnosis )

(3) Neither cholesterol crystals nor bilirubin calcium pigment were found on a single drainage in four cases of cholelithiasis, although concentrated bile was obtained in each case

(4) An absence of concentrated bile without microscopical pathological elements in the drainage bile was associated with calculi in eleven cases

If our findings lead us to believe that the patient has biliary-tract disease and we have ruled out to our satisfaction pleurisy, renal calculus, ulcer of the stomach or duodenum, appendicitis, cardiac disease and syphilis, we determine at this stage whether we shall treat the case medically or surgically

If the history and the laboratory findings point to biliary disease as the diagnosis, operation is advised. However, if there is anything in the case contra-indicating surgical intervention or if there are domestic or environmental factors affecting the patient, she is cared for medically, at least for the time being. In these cases the diet is regulated and the patient is given a printed form of instructions. In addition to dietary regulation the patients are advised how to avoid constipation, for it is well known how very essential this is when there is an associated disease in the biliary tract

If we decide that a case should have surgical intervention, the patient is admitted to the ward. Up to this time there has been no hospitalization, which is a saving to both the patient and the hospital. The findings from previous examinations in the clinic go with the patient to the ward. Here the patient is given the following work-up: Icteric index, blood cholesterol, blood sugar, non-protein nitrogen, bleeding time, clotting time, van den Bergh test, bile in fæces, bile in urine

The patient is given a mild cathartic and started on forced fluids and carbohydrates by mouth. If we feel that the patient has not received enough of this by mouth, a hypodermoclysis of 1,500 cubic centimetres 5 per cent glucose is then given

The type of anæsthesia is now determined. If there are no contra-indications, we prefer to use spinal anæsthesia. No other anæsthesia gives as good relaxation for work in the upper abdomen. We also use ephedrine hypodermically in conjunction with the spinal anæsthesia. Our incision of choice is the upper right rectus

Having once entered the peritoneum, we now determine the amount of pathology present in the gall-bladder and common duct. Our preference is cholecystectomy rather than cholecystostomy. If the patient is well along in years or if it would apparently be very difficult to do a cholecystectomy and therefore jeopardize the patient's chances of recovery, we do a cholecystostomy

All gall-bladders are aspirated under sterile precautions and these specimens of bile are sent to the laboratory for culture. Most of our gall-bladder bile cultures are reported sterile, in occasional cases we have found the colon bacillus, streptococcus and *Staphylococcus aureus*

As to whether the gall-bladder should be removed from its liver bed from below upwards or from above downwards, we feel is a matter which should be considered separately with each individual case. In many instances where exposure is adequate it is better to deal with the cystic duct and vessels first and then remove the gall-bladder from its bed from below upwards. On the other hand, there are many cases in which this procedure is technically very difficult, as for instance, in the very fat individual or in the acute, greatly thickened, distended gall-bladder where exposure of the cystic duct is very hard to obtain. In these cases it is much simpler to free the gall-bladder from its liver bed first, after which it can more easily be delivered and adequate exposure of the cystic duct secured.

In ligating the cystic duct and vessels, we prefer to use fixated ligatures. We open the common duct only when palpation reveals the presence of a stone therein or when there is reasonable doubt as to one being present. If the common duct has to be opened, we prefer to insert a "T"-shaped tube into it, or a drain down to where the common duct has been opened, we rarely ever attempt to close the opening.

Having finished the work to be done in the abdomen, a cigarette drain is always placed down to the stump of the cystic duct, the wound is closed in layers, medium-sized dermal suture material being used for retention sutures, which sutures include all layers except the peritoneum. Before leaving the operating table the patient is given an ampoule of pitressin and after being transferred to the ward another ampoule is given, and every four hours thereafter for the first twenty-four hours, with rectal tube *in situ*. We have found that this drug helps to prevent distention post-operatively. Patients treated with pitressin seldom have to be catheterized. For the first eight hours following spinal anæsthesia, the shock position is maintained. After eight hours the patient is placed in the partial Fowler position and the nurse in charge is instructed to change the position from side to side at frequent intervals.

One thousand cubic centimetres of 5 per cent glucose as a hypodermoclysis is given twice a day until the patient is able to take fluids by mouth and sufficient morphine is given to control the pain. The intra-abdominal drain is loosened on the fifth day and is removed on the seventh day.

Patients are confined to bed for about fourteen days. When leaving the hospital they are given a card which refers them back to the Gall-Bladder Clinic with an abstract of the hospital record. The patients are requested to report to the Gall-Bladder Clinic every two weeks to begin with, and it is impressed upon their minds that the operation is only a part of the treatment if they wish to keep well.

The following summary is based upon 200 cases in which the operative findings disclosed either cholelithiasis, cholecystitis or a combination of the two. It does not include those cases in which operation revealed a normal gall-bladder, malignancy or pathology of the neighboring organs.

## GALL-BLADDER SURGERY

	<i>Sex</i>	
Females		161, or 80.5 per cent
Males		39, or 19.5 per cent
	<i>Age</i>	
10-20		1.0 per cent
20-30		15.0 per cent
30-40		35.0 per cent
40-50		26.5 per cent
50-60		15.5 per cent
60-70		6.0 per cent
70-		1.0 per cent

*History*—The chief complaints were (1) indigestion and (2) pain in the gall-bladder region, either dull and aching in character or colicky and intermittent in type. The pain was referred to the right shoulder in 49 per cent of the cases. The pain was worse after food in thirty-one instances, these same thirty-one being relieved by vomiting. Nausea and vomiting occurred at some time in 85 per cent of the cases. Transient jaundice was present in thirty-seven patients and persistent jaundice in five.

*Physical Examination*—The important physical findings may be enumerated as follows:

Obese	53 per cent
Jaundice	21 per cent
Tenderness over gall-bladder	88 per cent
Fever	35 per cent
Rigidity	57 per cent
Tumor	14 per cent

In analyzing the various procedures followed in the operative work we note the following:

Incision: Upper right rectus	195 cases, or 97.5 per cent
Kocher	5 cases, or 2.5 per cent
Cholecystectomy	190 cases, or 95.0 per cent
Cholecystostomy	10 cases, or 5.0 per cent
Choledochostomy	7 cases, or 3.5 per cent

The operative findings may be summarized as follows:

Chronic cholecystitis with stones	124 cases
Chronic cholecystitis without stones	51 cases
Acute cholecystitis with stones	21 cases
Acute cholecystitis without stones	4 cases

It can thus be seen that we are doing cholecystostomy very infrequently, even in acute cases. About the only time that we feel it should be done is where the procedure of cholecystectomy would add sufficient shock to the patient's condition to possibly affect the outcome of the case.

The common duct was opened in seven instances for the removal of calculi. We do not favor opening the common duct for exploration unless we have fairly presumptive evidence that calculi are present therein.

As far as the important complications are concerned they may be summarized as follows and do not require any further comment

Hæmorrhage	1 case
Pneumonia	5 cases
Evisceration	3 cases
Phlebitis	1 case
Massive collapse of lung	1 case
Bile sinus, twenty-one days	1 case
Pulmonary embolism	3 cases
Wound infection	11 cases
Cardiac decompensation	2 cases
Dry pleurisy	1 case
Pansinusitis	1 case
Chronic bronchitis	1 case

Of the 200 operated cases, fourteen died post-operatively, a mortality rate of 7 per cent. The causes of death were as follows

Post-operative pneumonia	5 cases
Shock (death within forty-eight hours from so-called "liver deficiency")	3 cases
Pulmonary embolus	3 cases
Cardiac decompensation	1 case
Post-operative hæmorrhage	1 case
Massive collapse of lung	1 case

Of the above causes of death, we should like to call attention to the three deaths listed under shock. These patients all presented the same clinical picture. For twenty-four hours after operation they presented nothing unusual. At that time, however, there was a sudden rapid rise in temperature to over 106°, accompanied by an increase in the pulse rate to 140+. The skin became cold and clammy, the pulse became weak and thready, respirations became rapid and death occurred within twenty-four hours after the onset of the symptoms. Transfusions of whole blood, infusions of saline and glucose and stimulation with adrenalin and caffeine were all utilized without affecting the end-results. There was no evidence of hæmorrhage and nothing could be found in careful physical examination to account for the sudden syndrome of symptoms ending in death. Unfortunately, autopsy permission could not be secured in any of these cases.

This syndrome has been described by several other observers, and it has been assumed to be due to a sudden liver deficiency or imbalance due possibly to injury to a branch of the hepatic artery at operation or to a fulminating ascending cholangitis. In all of our cases the operative procedure consisted of simple cholecystectomy and in each case a chronically inflamed gall-bladder, containing calculi, was found. Blood chemistry estimates, done pre-operatively, gave normal figures throughout. It is difficult to explain why a simple cholecystectomy should cause a sudden interference with liver function, but suffice it to say that the deaths in these cases are otherwise

## GALL-BLADDER SURGERY

unaccountable and that the picture develops with dramatic suddenness and does not simulate any other post-operative complication that one can think of

Of the 200 patients operated upon in which gall-bladder pathology was found, there were fourteen deaths, leaving 186 cases to be followed. We were successful in obtaining a careful follow-up of ninety-three patients. The remainder could not be followed over a long enough period to be of value.

Of the ninety-three patients followed, the time since operation has varied from six months to five years.

In the follow-up of these gall-bladder cases we have naturally stressed the relief of symptoms which the patients complained of when first seen. The principal symptoms were pain or indigestion and in some cases jaundice. The pain was either of the typical biliary colic type, with radiation to the back or right shoulder, or was more or less constant in the region of the gall-bladder. Under indigestion we have grouped the following complaints in the order of their frequency: (1) belching, (2) feeling of fullness in epigastrium, (3) distress after eating and (4) nausea with or without vomiting. The jaundice, of course, was usually transient, coming on after an attack of biliary colic, and implying an obstruction to the common duct.

### (I) *Chronic Cholecystitis with Stones—Sixty-four Cases*

Five patients had attacks of pain for variable periods following operation but were otherwise symptom-free.

Four patients had persistent symptoms of indigestion but were otherwise symptom-free.

One patient had one attack of transient jaundice which did not recur. There were no other symptoms.

There were thus nine patients in this group who had definite symptoms post-operatively, and in whom one can assume that operation did not result in a symptomatic cure.

### (II) *Chronic Cholecystitis without Stones—Twenty-three Cases*

Here we find three patients complaining of attacks of pain post-operatively and ten patients presenting symptoms of indigestion. There remain ten patients who have been symptom-free.

### (III) *Acute Cholecystitis with Stones—Five Cases*

All these patients have been symptom-free since operation.

### (IV) *Acute Cholecystitis without Stones—One Case*

This patient has been symptom-free since operation.

Thus, of the ninety-three patients followed, seventy-one patients, or 77 per cent, have been relieved of all symptoms by operation and have remained well over a follow-up ranging from six months to five years.

## CONCLUSIONS

(1) Two hundred operated cases of gall-bladder disease, with a discussion of cholecystography and biliary drainage, are reported.



(2) Of ninety-three patients followed, there was a symptomatic cure in seventy-one patients or 77 per cent

(3) Cholecystectomy is the operation of choice Cholecystostomy has been done very infrequently

(4) We do not favor choledochostomy as a routine procedure but feel it should be reserved for those cases in which there is some definite evidence of the presence of calculi in the common duct

(5) A special clinic for the pre-operative work-up and the post-operative follow-up of gall-bladder patients is considered highly desirable

(6) Cholecystography and biliary drainage are both of great value in the diagnosis of gall-bladder disease, but should be considered in conjunction with each other and with the history and physical findings in each case

(7) X-ray findings were confirmed by operation in 72.2 per cent of the cases examined

(8) The presence of cholesterol crystals or bilirubin calcium pigment or both in biliary drainage bile is usually associated with cholelithiasis The absence of concentrated bile in repeated drainages indicates biliary-tract pathology even in the absence of pathological microscopical elements

(9) A normal drainage when not in agreement with the history and roentgenological findings should be repeated

# IMPROVED GALL-BLADDER TECHNIC

WITH ESPECIAL REFERENCE TO OMISSION OF DRAINAGE

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FROM THE DEPARTMENT OF SURGERY OF THE DE COURCY CLINIC

IN OPERATING upon diseased gall-bladders, a number of problems suggest themselves to the surgeon. While some of them may seem trivial at first glance, not infrequently attention to details such as these represents the margin of safety for the patient. They may not be neglected if only for the reason that they augment the comfort of the patient.

In describing a technic for drainage or removal of the gall-bladder, or drainage of the common duct, the problems of technic have to do with such details as preferable location of the incision and the best means of getting proper exposure. Aside from actual technic, it is the object of this paper to discuss, in addition, whether or not a cholecystostomy or a cholecystectomy should be performed, whether or not the common duct should be opened and explored, or merely palpated, and, especially, whether or not drainage is necessary or even desirable following simple cholecystectomy when the common duct is not opened.

For sake of clarity, we shall consider the various aspects of our subject in the relative order of their occurrence, were we now actually in the operating room with our gall-bladder patient before us on the table. The discussion will carry us, then, through such topics as pre-operative precautions, the technic of exposure of the operative field, the choice of procedure when the abdomen has been explored and, as mentioned previously, the controversial subject, to drain or not to drain.

Pre-operatively, it is always well to remember several possible post-operative accidents in gall-bladder surgery. One of these is dehydration. Dehydration is prone to become excessive especially when drainage of the gall-bladder is prolonged, as after cholecystostomy. Increased fluids are necessary in these cases. Glucose is especially indicated both before and following all operations upon the gall-bladder to sustain the glycogen reserve of the liver. Some surgeons advocate, also, pre-operative blood coagulation time tests and other blood tests in anticipation of the post-operative possibility of occasional grave hæmorrhage from the cystic artery. Precautionary measures for the prevention of other post-operative accidents, such as icterus, will be discussed farther along in my paper.

*Exposure of the Operative Field*—In referring to the literature, we find a formidable array of types of incisions for gall-bladder exposure: transverse, longitudinal, combinations of two or more, and so on. In our practice at the De Courcy Clinic, we have never used any but a longitudinal

incision beginning at the rib margin and extending to the transverse fold of Douglas, one-quarter to one-half inch mediad from the outer margin of the right rectus muscle

The technic for exposure of the parts is as follows. The rectus is split as in the Deaver appendix incision. Then a self-retaining retractor is inserted and a median retractor is placed under the rib and held by an assistant. The gall-bladder is next grasped with a hæmostat *without teeth* and pulled upward by traction, bringing the liver with it. A forceps with teeth must not be used for this purpose. Occasionally, however, the gall-bladder will be so friable as to make this method of traction impractical. It will then be better to grasp the gall-bladder in the left hand with gauze, pulling it into the field of vision in this manner. Usually, however, the hæmostat can be used successfully for this purpose.

After elevating the gall-bladder and eventrating the liver, we lay a laparotomy sponge over the bowels and press a broad flat retractor down on top of the sponge so as to expose the lower end of the gall-bladder with the common duct and the fixed portion of the duodenum. Frequently a second hæmostat may be placed upon the gall-bladder near the cystic duct so as to improve the exposure. The soft, fatty tissues are then separated over the cystic and the common ducts by blunt dissection. We use a curved hæmostat for this purpose. As the tissues surrounding these ducts are usually quite friable, they may easily be broken through by pushing the hæmostat into the tissues and then separating the blades.

Before the type of surgical procedure may be determined, a careful survey of the gall-bladder, the stomach, the pancreas and the surrounding structures must be made. The findings will predetermine whether cholecystostomy or cholecystectomy is the procedure of choice, and, if the latter, whether drainage may be omitted or is indicated. Is the gall-bladder acutely inflamed? Is there any outlying infection, as evidenced by recent adhesions? Is there subacute or acute pancreatitis? Answers to questions such as these will determine whether or not drainage is imperative. Is there obstruction in the common duct? Has there been deep jaundice? Answers to questions such as these will help to determine the choice between cholecystostomy and cholecystectomy. Let us not forget to mention, also, that the exploration of the pathological field may disclose an anomalous biliary tract development in a small percentage of cases. I will take this up more fully before I close this paper.

*Cholecystectomy Versus Cholecystostomy*—While cholecystectomy is, in my experience, the procedure of choice for the average gall-bladder case, I realize that this is a controversial subject in which all are not of a similar opinion. It will, perhaps, be fitting at this point to undertake a few of the reasons why I personally prefer cholecystectomy to cholecystostomy in uncomplicated cases.

Though physiologically it is still undetermined whether or not we are in error to remove the gall-bladder, practically it has been my experience that, after cholecystectomy, there is a lower rate of mortality, a lesser

incidence of recurrence of symptoms, fewer digestive disturbances, a smaller incidence of post-operative hernia, and a more rapid and a smoother convalescence. Though we may eventually discover sufficient physiological evidence to persuade us it is best to preserve the gall-bladder even when it is diseased, there does not presently appear to be any conclusive argument for not removing it. Patients from whom the gall-bladder has been removed seem to function as normally as before. On the other hand, there is, in my mind, a strong argument in favor of the removal of a diseased gall-bladder, since so seldom does such a gall-bladder resume a picture of health and proper function even after cholecystostomy.

In a previous paper\* I presented a study of 400 gall-bladder operations performed at the De Courcy Clinic. These cases were followed up every six months so as to secure an accurate picture of the remote results. We found that recurrence of colic and stone was much more frequent after cholecystostomy than after cholecystectomy. Symptoms of indigestion, though often persistent after cholecystostomy, were scarcely ever complained of after gall-bladder removal. These cases demonstrated, too, that prolonged deviation of bile from the intestinal tract, as in cholecystostomy, results in a gastric-biliary imbalance which is evidenced symptomatically by indigestion and headache, as well as the various reactions of dehydration.

I have found that the patient spends on an average approximately four less days in the hospital after cholecystectomy than he does after cholecystostomy. Also, cholecystectomy in my cases has reduced post-operative hernia incidence by half.

A further argument in favor of cholecystectomy is based upon the fact that frequently stones are so completely imbedded in the walls of the gall-bladder that they could not possibly be removed by cholecystostomy. To be forced to leave these hidden stones within the gall-bladder or even to overlook them would be a probable source of recurrence of the symptoms which originally brought the patient to operation.

A word may be said, too, about the hepatitis which is frequently present in gall-bladder disease. I believe that this is usually a secondary manifestation, not requiring drainage. In fact, I have found that in most cases it disappears more rapidly following removal of an infected gall-bladder than following cholecystostomy.

So far as comparative mortality figures are concerned, I would like to call attention to a series of 416 consecutive gall-bladder operations taken from the files of the Good Samaritan Hospital. Included in this number were ten cases in which the common bile-duct was drained in conjunction with the other operation, but I have been unable to segregate further data concerning these cases. Classification of this series of 416 cases showed that there were 336 cholecystectomies and eighty cholecystostomies. Of the deaths, there were twenty-one after gall-bladder removal, or 6.2 per cent, as against fourteen deaths after drainage only, 17.5 per cent.

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\* De Courcy, J. L. Gall-bladder Technic. ANNALS OF SURGERY, February, 1927

I have taken the trouble to separate and classify my personal cases in this series to see if this markedly lower mortality incidence after gall-bladder removal is corroborated by my own series of cases. I personally operated on seventy-seven cases, that is, seventy gall-bladder removals and seven cholecystostomies. My mortality incidence after cholecystectomy was only 4.2 per cent (three deaths), as against 28.5 per cent (two deaths) after cholecystostomy. It is fair to state, however, that only the more severe cases were subjected to drainage. This would account to some extent for the rather excessively high mortality rate in the cholecystostomy cases.

Though I consider cholecystectomy the preferable operative choice in most cases, I agree that cholecystostomy has definite indications and should not be discarded altogether. Let us consider, for instance, the case of a stone obstructing the common duct. The procedure is to remove the stone, inserting a drainage tube into the duct. Then, if the jaundice is not too deep, cholecystectomy may be performed. However, if there has been a persistent icterus for some time, it would be better to do a cholecystostomy to secure drainage of the dammed-up bile, and in this case it is better to defer removal of the obstruction in the common duct for a few weeks.

There is another type of case, also, in which cholecystectomy is contraindicated, and that is in the presence of malignancy of the pancreas. Here the gall-bladder should never be removed as it can be used later to anastomose to the stomach or the jejunum, should the ampulla of Vater become obliterated.

*Technic for Cholecystectomy*—When cholecystectomy has been decided upon, the following technic is observed in our clinic. We usually elevate the gall-bladder rest under the patient about four inches for cholecystectomy. Occasionally, we have used a reversed Trendelenburg position during the operation. First, the cystic duct is grasped between two curved hæmostats and is cut through (Fig 1). The stump is then tied with single No. 2 chromic gut and allowed to drop. There is a precaution to be observed here, however, and that is the necessity of stripping all the adjacent tissues away from the cystic duct before tying it. If fatty tissues are included in the ligature, there is apt to be post-operative drainage. With the duct stripped clean before ligature, drainage does not occur. It must be remembered too, that the cystic duct enters the common duct from the back rather than anteriorly or at the side. Hence, in isolating the cystic duct, great care must be taken not to injure the common duct. The best procedure, I have found, is to use blunt dissection for exposing and stripping the cystic duct. Blind grasping with the forceps and ligation *en masse* should be avoided.

It is now necessary to tie off the cystic artery. However, the artery does not need to be exposed for this purpose, a satisfactory ligature may be made by passing a suture on a curved needle through both layers of the peritoneum, sufficiently deep to insure tying-off of the artery. The suturing is then continued upward as the gall-bladder is removed with sharp dissectors, starting from the duct end and working toward the blind end.

## GALL-BLADDER TECHNIC

At one time it was my custom to remove a gall-bladder by starting from its distal blind end and working toward the cystic duct. Later I found that I had better control of the operative field by working in the opposite direc-

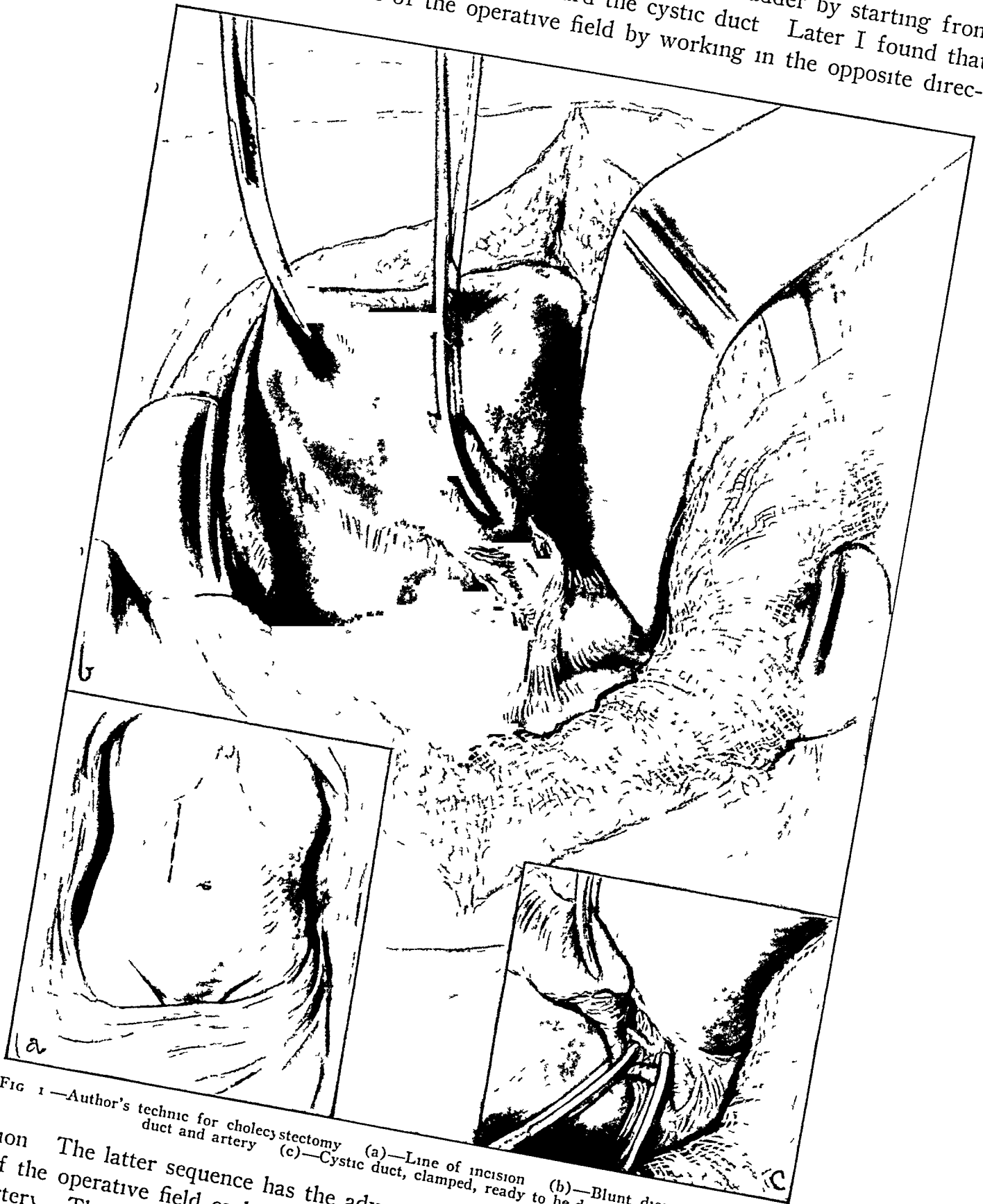


FIG 1—Author's technic for cholecystectomy (a)—Line of incision (b)—Blunt dissection of cystic duct and artery (c)—Cystic duct, clamped, ready to be divided

The latter sequence has the advantage of controlling the blood supply of the operative field early in the operation through tying off of the cystic artery. Thus, the field of operation is kept clear of hæmorrhage and a more

preserve a perfect operating technic. This applies when there is a large amount of inflammatory thickening, as in acute empyæma, when there is outlying infection, and when it has not been possible to institute perfect hæmostasis. It is advisable, too, to use drainage tubes when the gall-bladder difficulty is complicated by subacute or acute pancreatitis. Drainage must be used, also, when it has not been possible to preserve enough peritoneum to cover the stump of the cystic duct and the raw bed of the liver from which the gall-bladder has been enucleated. Drainage tubes must, of course, always be utilized in cases in which it becomes necessary to drain the common bile-duct.

On the other hand, it has been our experience that the technically perfect operation is possible in the majority of gall-bladder removal cases which come to operation. I define the technically perfect cholecystectomy as one in which, in the absence of local or outlying infection, it has been possible (1) to secure perfect ligation of the cystic duct and effective hæmostasis, and (2) to peritonealize the stump of the cystic duct and the raw wound on the surface of the liver so as to prevent the escape of bile.

A device for discovering whether or not there are any focuses in the wound oozing bile or blood before the abdomen is closed may be utilized as follows. Moisten a gauze sponge with saline solution and pack it lightly over every portion of the operating field so as to secure an impression on it of any oozing surfaces. If examination of the gauze shows blood or bile stains, the exact location of the oozing may be ascertained by the application of a fresh sponge. If you cannot, then, repair the seepage sufficiently, there is no other alternative but to use the drainage tube.

There are many advantages, to my mind, to be gained by the omission of drainage. They are best impressed upon our minds, perhaps, by enumerating the disadvantages and dangers of the drainage process. When the drainage tube is used, periduodenal and pericolic adhesions frequently become fixed around the tube in the healing wound. When the tube is removed, not only is it a painful process but a dangerous one as well, since it disturbs and tears the adhesions. Removal of the drain lays the patient open to the danger of a possible serious septic infection, often it causes disturbing hæmorrhages as well. With regard to post-operative hernia, while all patients with drainage do not run the risk of hernia, there is, in my experience, a larger percentage of hernia incidence after cholecystectomy with drainage than without drainage.

Briefly, cholecystectomy without drainage permits a shorter and more comfortable convalescence, insures maintenance of the biliary flow into the gastric tract during convalescence with fewer digestive symptoms, and is unattended by many of the inconveniences which hinder recovery when drainage is utilized.

We cannot omit drainage in every case, but, on the other hand, with more careful technic not so many cases will require drainage. I feel sure that I shall drain fewer and fewer cases in the future.

## GALL-BLADDER TECHNIC

Before I leave this debatable question of whether to drain or not to drain, it will be pertinent to examine the mortality percentages in the series of 336 consecutive cholecystectomies performed at the Good Samaritan Hospital, mentioned earlier. Three hundred of these cholecystectomies were drained, thirty-six were not drained. In those drained, the mortality percentage was 6.6 per cent (twenty deaths), as against a 2.7 per cent mortality in those not drained (one death).

Seventy cholecystectomies in this series were my own cases. Since drainage was omitted whenever possible, the mortality percentages in the drainage and the non-drainage groups may be compared. Thirty-six of these cholecystectomies were drained and drainage was omitted in thirty-four. In the drainage group, there were three deaths, or an 8.3 per cent mortality. In the non-drainage group, there were no deaths. As has been mentioned previously, one must, in fairness, recognize the fact that the cases drained were of a more serious nature. Hence, the mortality rate would of necessity be higher. Though this is true, it also shows that, if discernment is used, omission of drainage does not increase the mortality. In other words, there were no deaths from leakage of bile in the undrained cases and bile did not drain when the drainage tube was omitted.

Another problem which confronts the surgeon when operating upon the gall-bladder is the question of anomalous developments in the biliary tract. The percentage of the incidence of biliary anomalies is larger than generally thought—about 10 per cent. A knowledge of the more usual forms they take is of some importance to the surgeon, since they represent potential surgical catastrophes.

Of anomalies of the gall-bladder, there is congenital absence, as well as doubling of the organ. Occasionally the gall-bladder will carry accessory bladders or pouches, or it may be bilobed. The surgeon must be ready to recognize, also, anomalous attachments of the gall-bladder, as for instance when it is freely suspended from the liver. Common anomalies of the cystic duct are its absence or its doubling. It may have unusual sites of termination, such as emptying into the left or the right hepatic ducts, into the stomach or the duodenum or farther down the common duct than normally. Likewise, the common duct may be congenitally absent, may be doubled or may have unusual sites of termination, as into the stomach.

Multiple hepatic ducts are rather frequently encountered, and the so-called "cyst hepatic ducts" have especial significance to the gall-bladder surgeon since, when severed, they are a potential source of post-operative bile leakage. These cyst hepatic ducts drain from the liver into the side of the gall-bladder or into the cystic duct. They are not distinguishable during operation because of their small size. Though few of the cyst hepatic ducts will drain bile seriously after operation, yet they are a potential source of seepage in some cases of post-operative bile peritonitis. If their presence is suspected, the focus should be ligated or seared with a cautery. Venous connections between the liver and the gall-bladder should be similarly handled.



# CORRELATION OF SYMPTOMS, PATHOLOGY AND RESULTS IN CHOLECYSTECTOMY\*

A STUDY OF TWO HUNDRED THIRTY-THREE CHOLECYSTECTOMIES DONE IN  
VANDERBILT SCHOOL OF MEDICINE FROM 1925 TO THE  
MIDDLE OF MAY, 1932

By WORCESTER A. BRYAN, M D  
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Two hundred thirty-three cholecystectomies were done by all operators in the period covered by this study, which is undertaken with the view of determining, as far as possible, the dependability of clinical symptoms and cholecystography to assure the surgeon that he will find a definite pathological process involving the biliary structures and thus justify the operative measures he has advised

The clinical findings indicative of gall-bladder pathology are so varied, so variable, in both intensity and constancy, that such studies as this cannot fail to apprise one of the margin of error attaching to the whole of the diagnostic process, but even to bring this error down more specifically to certain classes of cases, and show that under one group of findings the pathological changes justify the treatment almost, but not quite, 100 per cent, while in another group of less exact clinical evidence taken as a whole, the treatment is more frequently not justified by the findings, although some of the items of clinical evidence may be accepted as almost or absolutely pathognomonic. To put the problem in question form, what symptoms and signs warrant the physician in urging operation? What variations in these suggest caution? And what demand refusal of surgical intervention? I am fully convinced that unconditional answer to each of these questions would lead the operator into error. In the first, because he will under the most positive evidence do a very rare unnecessary operation and find a normal gall-bladder, in the second, where caution is suggested, he will, in spite of its most conscientious use, find himself wondering about his justification still more often, in the third, when and if he refuses all of a group having so few or such insignificant evidences of gall-bladder disease, he is sure to impose thereby a continuation of definite pathology in a considerable number of these people, who have a right to be well, just as if he operates on this whole group he will operate unnecessarily on very many of them

## DEFINITION OF TERMS

### *Clinical Manifestations*

(1) *Typical*—Repeated attacks of gall-stone colic or palpable tender gall-bladder

(2) *Atypical*—Chronic indigestion    Soreness at right costal margin

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\* Read before the Texas Surgical Society

## CHOLECYSTECTOMY

### *Cholecystography*

- (1) *Positive* —No shadow or definite stone shadow
- (2) *Questionable* —Slight concentration
- (3) *Negative* —Normal shadow at any time

### *Pathological Changes*

- (1) Marked gross and microscopical changes
- (2) Slight gross, but definite microscopical changes
- (3) Indefinite gross or microscopical changes    Enlarged lymph-node

In the 233 cases, there were 112 which gave typical clinical findings and of these 81 per cent showed marked pathological change, 13 per cent slight but definite pathological change, and 6 per cent indefinite change, or 94 per cent at least of this group justified the procedure undertaken for their relief. One wonders why the 6 per cent gave evidence that necessitated their classification in the typical group. No fault can be found with the advice to submit to surgery, but with the fallacies leading to their classification among typical, when every final justification of discoverable pathology leads one to conclude that they do not belong in this classification, or to the conviction that changes so obscure as to escape discovery may cause symptoms and signs of characteristic type.

In the group having atypical signs and symptoms, there were 121 cases. Of these 37 per cent showed at operation marked pathological changes, 40 per cent slight pathological changes and 23 per cent indefinite pathological changes. In other words, there was four times as great a percentage of this group who, one might maintain, had been operated on unnecessarily as in the group showing typical symptoms. If we conclude to save the 6 per cent of the typical cases or the 23 per cent of the atypical cases from questionable or unnecessary surgery, we can do so only by refusing also all those 94 per cent who had warrantable pathology in the first and 77 per cent in the second group, for there is no evidence in our records that enables us to separate those frankly needing surgical relief from those who from our present inadequate knowledge of the early internal pathology of cholecystitis seem to have needed it less or not at all. Are we in a position to say that these questionable cases have not had a more active inflammatory process in times of previous attack recognized or not, and can we say that such attacks are not practically certain to recur in the future? If these questions be answered affirmatively our conduct is eminently correct in removing the gall-bladder, not only on account of immediate and easy cure, but because such early removal (before gross proof of the correctness of our action) prevents that group of grievous secondary changes following and growing out of the disease localized in the bile passages. These complications are responsible for the vast majority of deaths in gall-bladder cases, and, whether recognized or not, probably for a majority of the operative deaths. Furthermore, such changes are incurable, myocardial degeneration, pancreatitis and secondary diabetes, nephritis, hepatitis. They too must be responsible, having ad-

vanced to a certain grade, for our failure to deliver satisfactory cures in a goodly per cent of operated cases, when death comes on account of these complicating sequelæ, especially if the gall-bladder has been quiescent a long time, the cause of death is ascribed to the lesion in evidence at the time and the boards of health fail to learn the true relation an old cholecystitis holds to the facts. The remote cause of the immediate cause of death is the real cause of death. This is all-important when cause one is discoverable and curable and cause two is insidious, remote, progressive. Prophylaxis against cause two and not the discomfort of immediate symptoms is the best reason for cholecystectomy.

One hundred thirty-seven cases were subjected to cholecystography, the chief hope on which surgeons relied for relief from the embarrassment caused by their inability to determine, once their hands were upon it, whether this gall-bladder should be removed or left, and from the chagrin caused by continuance of symptoms if it was left and contrariwise continuance if it was removed. These evils may not happen often, but they do happen both ways.

Of 137 cases studied by cholecystography eighty-nine showed no shadow of these 72 per cent were markedly pathological, 19 per cent slightly pathological and 9 per cent showed indefinite pathological change. Thirty-five cases showed slight shadow of these 17 per cent showed marked pathology, 48 per cent slight pathology, and 35 per cent indefinite pathology. Thirteen cases showed good shadow of these, two cases or 15 per cent showed marked pathology, 55 per cent showed slight pathology and 30 per cent showed indefinite pathology. Or, to interpret, there were nine cases in 137 showing no discovered evidence of disease by cholecystography who showed definite pathology at operation, there were eight cases out of eighty-nine showing no shadow who on operation were classed indefinite, and twelve cases of thirty-five showing slight shadow who were found to have indefinite pathology. Another statement of these findings may be given 9 per cent giving no shadow showed indefinite pathology, 35 per cent of those showing slight shadow had indefinite pathology, and 70 per cent of those showing good shadow had definite pathology, enough presumably to satisfy the various surgeons operating that their therapy was correct. Of course, the number of cases is far too small for finalities, but as far as the figures go they seem to indicate that positive findings (negative shadows) are much more dependable than negative findings (positive shadows).

The group of cases who were operated on without having cholecystography numbered ninety-six. Fifty-nine of these had typical clinical symptoms and thirty-seven did not show typical symptoms. Of the fifty-nine typical cases 67 per cent revealed marked pathological change, 23 per cent slight pathological change, and 10 per cent indefinite change. If we construe indefinite pathological change to mean inadequate or undiscoverable, or no change, then it becomes apparent that even in cases with typical classical text-book symp-

toms there is an error of 10 per cent, provided we admit (which I doubt if we can) that the pathology was so insignificant or so absent as to cause the surgeon to feel that this 10 per cent would have been as secure in health without the operation as with it. Some feeling of this kind rather generally distributed must have been responsible for the great enthusiasm felt when we first learned the possibility and practicability of cholecystography by the administration of a selective dye. Later, by hard lessons, it was found that the interpretation of these X-ray plates for the patient's advantage was much more difficult than their production. The question of the border between normal and pathological arose here just as it has in all clinical data. We hoped cholecystography might prove pathognomonic. As might have been expected, it did not. Nothing ever has proved to be

The other parts of this group must be considered before conclusions are attempted. Thirty-seven patients having atypical symptoms were operated on. Thirty-five per cent of these had marked pathology, 40 per cent had slight, and 25 per cent indefinite. It may be accepted, I believe, fairly that in all these tables the percentage listed as having indefinite pathology contained some cases which had no pathology and had never had any. If any such were present they were operated on unnecessarily. In the preceding paragraph or two, it was lamented that as much as 10 per cent of the typical cases should fail to show convincing pathology. That being so, what word can be used to express the grief at finding this percentage rise to twenty-five? Yet, turned around, the picture is very different. If it should be decided to advise all cases having indefinite symptoms against operation, a much less justifiable situation confronts one. For, if in the second class in this group, refusal to operate on all the cases had been offered to save nine people (25 per cent) from unnecessary or questionable operation, twenty-eight people (75 per cent) would have been condemned to continue with their incurable lesions. The question raised by such observations is whether the surgeon should cease to recommend operation to save such part of the 25 per cent as have no pathology from unnecessary operation, or continue the recommendation with a constant effort by personal accomplishment and by the use of every diagnostic measure to reduce the errors to a minimum.

Assembled with reference to history and cholecystogram the total group of cases present the following analysis. Fifty-nine cases with typical history, but no cholecystogram, gave 86 per cent with marked pathological change, 12 per cent with slight change, 2 per cent with indefinite change, which gives the smallest percentage of questionable pathology of any except those which gave the same figure of 2 per cent in those cases presenting typical clinical findings. In the group with typical history having cholecystogram with no shadow forty-one cases showed 90 per cent with marked, 7 per cent with slight and 3 per cent indefinite. This is practically the same as in the last named group and should be the same. One would hardly expect the addition of a cholecystogram to reduce the minimum

below 2 per cent, and it is certainly absurd to think the negative cholecystogram would raise the minimum. A point of largely academic interest here is that a negative cholecystogram would necessarily occur in those rare cases whose gall-bladder is congenitally absent. I have seen one such case, in another hospital, who had no symptoms, no history of cholecystitis. Exploration of the upper right quadrant during an operation for appendicitis was responsible for the discovery. There is no record of congenital absence of the gall-bladder in the present series of cases. When the history is not typical in forty-eight cases and a cholecystogram showed no shadow, 56 per cent showed marked, 29 per cent slight and 15 per cent indefinite pathology. The variance between this and the last two groups is 12 to 13 per cent, showing apparently the superiority of history over cholecystography. But in the next group of thirty-seven cases where the history was not typical and no cholecystogram was made the percentages were marked 35, slight 40, indefinite 20, or 10 per cent more questionable cases than in the last group. Showing thus apparently the valuable service of X-ray study in cases with an indefinite history. I saw a case in another hospital (not included in this group) who had a rather questionable history, uncertain clinical evidence, and cholecystogram negative (showing both good shadow and good function) whose continued impaired health caused a request for repetition of cholecystography. This time it was positive. Operation disclosed cholecystitis with stones and relieved her of all symptoms.

When history was not typical and the cholecystogram gave a good shadow in ten cases 10 per cent showed marked, 60 per cent slight, and 30 per cent indefinite pathology. In cases with typical history and doubtful cholecystogram nine showed 22 per cent marked, 45 per cent slight, and 33 per cent indefinite pathology. Three cases with typical history and good shadow give one marked, one slight, one indefinite. In twenty-six cases with history not typical and doubtful cholecystogram 15 per cent were marked, 50 per cent slight, 35 per cent indefinite.

Study of these figures suggests that cholecystography is worth the most where needed the least and vice versa. In one group, the small variation may be eliminated and the percentages of indefinite pathology accepted as equal. In another group appears a variance of clinical service, for with atypical histories in both those having cholecystogram which showed no shadow result in 15 per cent indefinite, as compared with 25 per cent in similar cases having no cholecystogram. In the final group suggest that a doubtful cholecystogram has the same significance as a good one since the percentage of indefinites is practically the same and very high in all.

There were nine deaths in the series, a mortality of 3.8 per cent. Individual consideration of these deaths gives probably the most valuable practical information in this study.

CASE 3836—Aged forty-three, was ill four months, had intense jaundice. Stones in the common duct. Died three days after operation. No autopsy.

CASE 2005—Aged forty-five, was ill one week, had irregular fever, intense jaundice,

## CHOLECYSTECTOMY

positive blood culture, large stone in the common duct, with persistence of fever Died three weeks after operation Autopsy showed vegetative endocarditis

CASE 416—Aged sixty-nine, was diagnosed cholecystitis in 1925 Operation was not advised Returned in March, 1927, in an acute attack with intense jaundice There was a large fistula between the gall-bladder and the duodenum Convalescence very satisfactory for nine days Sudden death Autopsy revealed coronary thrombosis

CASE 3985—Aged sixty-nine, was considered a poor operative risk No clinical evidence of acute cholecystitis At operation an acute cholecystitis was found Post-operative course indicated mild peritonitis Died one week after operation No autopsy

CASE 4228—Aged twenty-seven, ill two days with signs of general peritonitis, was thought possibly to have acute appendicitis Acute cholecystitis was found at operation Died nine hours later No autopsy

CASE 1790—Aged forty-five, gave a typical history and was considered a good operative risk The gall-bladder, easily removed, was filled with stones Died four days after operation Autopsy revealed no cause of death

CASE 45517—Aged thirty-seven, had symptoms two and one-half years The diagnosis on admission was acute cholecystitis She was operated on four days after entering the hospital Her gall-bladder was markedly inflamed and contained stones Convalescence was uneventful until the seventh day, when she died suddenly Autopsy showed pulmonary embolism of undetermined origin as the cause of death

CASE 40352—Aged forty-five, had mild symptoms of cholecystitis and definite cardiac disease. Operation revealed no pathological changes in the gall-bladder Died five hours after operation Cause of death was myocardial hypertrophy and dilatation

CASE 42878—Aged eighteen, was a dwarf Had jaundice and bleeding from mucous membranes There was a stone in the common duct with white bile Died two weeks after operation of cholangitis

In nine deaths following 233 operations four fatal cases were definitely operated on in an acute attack If these had been deferred we should have had 229 cases with five deaths, or a mortality of 2.02 per cent

Eleven of the cases which showed indefinite pathology of the gall-bladder, when checked, gave the following results unknown, four, unimproved, six, well, one

# CONSERVATION OF HEPATIC FUNCTION IN GALL-BLADDER OPERATIONS

PRECAUTIONARY MEASURES TO PREVENT "LIVER DEATHS"

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IN RECENT years there has been a general recognition of the fact that in chronic disease of the gall-bladder the liver shows more or less pathological change, whether there is clinical jaundice or not

As early as 1917, Reimann, of the Lankenau Hospital, pointed out that histological study of small sections of liver adhering to gall-bladders removed at operation showed an almost constant occurrence of a certain degree of hepatitis associated with the cholecystitis (Deaver)<sup>1</sup> This was supported by Graham's<sup>2</sup> experimental studies in 1918, and has since been widely substantiated by biopsy studies of liver tissue removed at gall-bladder operations, in many clinics both here and abroad

The liver changes observed vary in character and extent The inflammation may be localized around the bile-ducts and blood-vessels, or there may be a diffuse hepatitis Biliary obstruction increases the liver damage In the most severe cases with jaundice, Albot and Caroli<sup>3</sup> note, the liver changes may resemble those of acute yellow atrophy

Yet it is a common finding that the degree of pathological change in the liver is not parallel with that of the gall-bladder A relatively slight hepatitis may be associated with a severe cholecystitis, a mild cholecystitis with more marked degree of hepatitis Judd,<sup>4</sup> of The Mayo Clinic, expresses the opinion that the hepatitis associated with cholecystitis may not represent a secondary inflammation of the liver, but rather "the remains" of a detoxifying process

If, then, the liver is damaged to a greater or less extent by the pathological lesions in the gall-bladder at the time of the operation, is it not logical to suppose that its functional activity would be still further reduced by the additional strain of the operation for the removal of the gall-bladder—the exposure and the unavoidable injury to tissues even with careful technic? That this is the case is indicated by the occurrence following gall-bladder operations of unexpected deaths not due to any of the usual causes Such deaths have recently been designated as "liver deaths"

Special attention was called to cases of this type by Cave,<sup>5</sup> in 1926, who reported that in a series of 575 cases of gall-bladder operations there were thirty-five post-operative deaths, in three of which the usual causes of death—hæmorrhage, peritonitis, pneumonia and embolism—were all excluded In these cases, the chief symptoms were a rapid rise in temperature and in pulse rate In all these cases the patients were considered good operative risks The operation was a cholecystectomy without technical difficulties and the

patients were not jaundiced' In all there had been a prolonged chronic cholecystitis and calculi were present in the gall-bladder In only one case did the records show any unusual liver traumatization The appearance or consistency of the liver was not noted At the time Cave expressed the opinion that death in these cases was due to "diseased or chemically altered liver cells or toxic bile "

In 1927, Behrend<sup>6</sup> also referred to similar "high temperature" deaths occurring after gall-bladder operations without any evidence of infection He stated that he had examined such cases post-mortem without finding the cause of death, but he failed to report a histological examination of the liver

In 1930, Stanton<sup>7</sup> reported that in 100 deaths following gall-bladder operations at the Ellis Hospital, Schenectady, N Y, fifteen were of a similar peculiar type with a rapid steady rise of temperature, greatly accelerated weak pulse, extreme nervousness and finally rapid, shallow respirations, and with no evidence of infection or hæmorrhage The clinical picture, Stanton notes, is that of "an overwhelming toxæmia" A very similar syndrome was observed in another case in which death resulted from a traumatic rupture of the liver, and Stanton is of the opinion that similar factors are operative in the gall-bladder cases as in the case of liver injury

Later Connell<sup>8</sup> reported seventeen cases of death of this type in a total of seventy-two post-operative deaths following operations on the biliary tract This author notes that a review of the post-operative records in laparotomies other than biliary-tract operations showed no similar syndrome He believes it to be due to "a chemical or metabolic reaction," the nature of which is unknown

At the Post-Graduate Hospital, New York City, records show a small group of cases of operation on the biliary tract in which death occurred without any definite cause These Heyd<sup>9</sup> characterizes as "liver deaths" In one group the symptoms were similar to those described by previous authors namely, rapid rise of temperature with accelerated pulse and respiration In these cases the icteric index was normal, but Heyd noted a gradual increase of urea nitrogen in the blood This type of "liver death" he attributes to "hepatic exhaustion" incident to the hepatitis associated with gall-bladder disease and the further damage resulting from surgical intervention The increased urea retention indicates a secondary renal failure

In the last few years, four unexpected deaths of this high-temperature type occurred at the Barnes Hospital of St Louis, following gall-bladder operations These patients were all apparently good risks for operation At autopsy definite pathological changes in the liver were observed which were identical with those found by biopsy at the time of the operation These changes were the same as those seen in other cases with cholecystitis, *i e*, cloudy swelling with some œdema and periportal inflammation (Graham)

More recently Helwig<sup>10</sup> and his associates at St Luke's Hospital, Kansas City, Mo, have made a special study of these so-called liver deaths In four cases the syndrome followed operations on the biliary tract, in one case a



severe trauma to the liver, and in one it was associated with a diffuse metastatic carcinoma of the liver

In these cases there was a rapid rise in temperature without infection and accelerated pulse. Progressive oliguria and increase in the nitrogenous elements in the blood developed. Death occurred in a state clinically resembling uræmia.

Although Heyd mentioned the increasing retention of urea in cases of this type, other authors have not emphasized the clinical evidence of renal involvement. Autopsy in Helwig's cases showed extensive degenerative changes in both liver and kidneys. In the liver, there were either leucocytic infiltrations, necrosis and interstitial hæmorrhages or parenchymatous and fatty changes. The kidneys showed parenchymatous swelling with degeneration of the tubular epithelium usually progressing to necrosis. The clinical records in the operative cases did not indicate any definite failure of liver function. Two cases showed slight jaundice. All these patients gave a history of chronic cholecystitis, and liver damage was noted at operation. Helwig is of the opinion that the post-operative symptoms and fatal termination are due not to failure of liver function, but to toxic products elaborated by the diseased liver, which act secondarily upon the kidneys.

Further important contributions on the functional capacity of the liver and the condition of "liver death" were made by Walters,<sup>11</sup> in 1931, and by Schutz, Helwig and Kuhn,<sup>12</sup> in 1932.

In my own experience in biliary-tract surgery, I have observed several cases of post-operative death showing this high-temperature syndrome without infection or hæmorrhage, with rapidly rising fever, rapid pulse, and the terminal uræmic syndrome. It is probable that such cases occur more frequently than the number of reported cases would indicate. The tragedy of these deaths is that they occur, as has been noted, in patients who appear clinically to be good operative risks.

It is especially important, therefore, to determine the condition and functional activity of the liver before any operation on the biliary tract, no matter how good the general condition of the patient may appear to be.

Various tests of liver function have been proposed and used. Chief among these are the determination of the icteric index, the van den Bergh test, the dye-retention test, and the galactose test.

The liver, as Judd<sup>13</sup> says, has "a multiplicity of metabolic functions." It is concerned with the metabolism of carbohydrates, proteins and fats, with the production of bile and of fibrinogen, and with detoxification. Probably no one test can be depended upon to reveal failure of liver function. At The Mayo Clinic, one of the dye-retention tests and the van den Bergh test are used as routine pre-operative measures in biliary-tract surgery. Others prefer the icteric index to the van den Bergh test, as it also depends upon bile-pigment formation and is a much simpler procedure. The galactose test is less widely used in American clinics, but it is of interest to note that a British surgeon, Flint,<sup>14</sup> of Leeds, found that, in a series of cases of gall-bladder

## THE LIVER IN GALL-BLADDER OPERATIONS

disease in which biopsy studies of the liver at the time of operation showed varying degrees of hepatitis, the galactose test was a better indicator of the degree of liver damage than the van den Bergh test. He did not employ any of the dye-retention tests in this study.

At the Jefferson Hospital, Philadelphia, Shallow emphasized the importance of pre-operative liver tests in patients with gall-bladder disease who were not jaundiced, as he had noted that in certain cases in which death occurred unexpectedly after operation, the dye tests had shown a high degree of retention (Robertson<sup>15</sup>).

In the dye-retention tests, the dyes that have been most frequently employed are phenoltetrachlorophthalein and bromsulphalein. After Graham developed his method of cholecystography for gall-bladder visualization with phenoltetraiodophthalein (isoiodeikon) given intravenously, he found that this same method could be used as a dye-retention test of liver function. If isoiodeikon is given in the amount usually used for cholecystography (about 2.5 grams to the average adult), it puts a heavier "load" on the liver than the amount of the dyes ordinarily used for liver-function tests. This liver-function test was in fact developed on the basis of the findings in the four "liver deaths" at the Barnes Hospital to which reference has been made. In these cases cholecystography had been done with the intravenous injection of the dye, and in reviewing the records it was found that there had been a high retention of the dye in all of them.

Since that time, patients showing a retention of more than 50 per cent of the dye in the first half hour are not operated upon immediately, but are prepared for operation by rest and large doses of carbohydrate—by mouth or as glucose intravenously. Small amounts of calcium are also given, as it has been found that the repair of damaged livers is hastened by calcium. Mortality from gall-bladder operations has been reduced since this routine was adopted for cholecystectomy from 6 per cent to 0.4 per cent, for common-duct operations, from 7.7 to 2 per cent.

One advantage of the Graham dye-retention test is that in clinics where cholecystography is done as a routine with intravenous injection of the dye in cases of biliary-tract disease, no additional intravenous injection is required and the number of procedures necessary for the study of the case is thereby reduced. Whichever method is preferred, some liver-function test, and preferably more than one such test, should be done *in every* case prior to operation on the gall-bladder. If any evidence of functional failure of the liver is found by such tests, glucose should be given in large amounts, preferably intravenously, before and after operation, and also small doses of a suitable calcium preparation may well be used.

In addition to such pre-operative and post-operative measures to maintain liver function and avoid "liver deaths" in biliary-tract surgery, certain features of the operative technic are also of importance. Care should be taken to avoid injury to the bile-ducts, the blood supply, or the nerve supply of the

liver, as any such injury increases the degree of liver damage incident to the operation and diminishes its functional integrity

It is of importance that the surgeon should thoroughly inspect the operative field with special attention to the course and any possible anomalies of the bile-ducts and the blood-vessels. Anomalies of both bile-ducts and the blood-vessels of the biliary tract are frequent. According to Behrend,<sup>6</sup> such anomalies occur in 25 per cent of cases. Injury to the bile-ducts involves biliary obstruction and thus increased damage to the liver. Injury to the blood-vessels of the biliary tract is of special significance to liver function because of the peculiarity of the blood supply of the liver, by which the individual liver cells receive blood only from the portal vein, the hepatic artery supplying the bile-ducts and the capsule of the liver. Hence, as Crile notes, "the interchange of the circulation in the liver cells is not between the arterial and the venous systems but between the portal and the biliary systems." And it is evident that any interference with the biliary supply must affect the portal circulation and the blood supply of the liver.

According to Crile's<sup>16</sup> theory, also, the operative exposure in biliary-tract surgery results in lowering the temperature of the liver, with consequent reduction of its functional activity and also interference with the heat regulation of the body, explaining the rapid rise of temperature characteristic of the type of "liver death" under discussion. To obviate this he has devised a method for the application of diathermy to the liver during as well as after operation. This method has not been generally adopted, but a recent monograph on biliary-tract surgery by an Argentine surgeon (Sobre-Casas<sup>17</sup>) reports the use of diathermy in his clinic at Buenos Aires both during and after operation. It may be that Crile's method of diathermy to maintain the temperature of the liver will prove to be a valuable adjunct of gall-bladder surgery.

Whether this method is generally adopted or not, the surgeon operating on the biliary tract, with even such a comparatively simple operation as an uncomplicated cholecystectomy, must give careful attention to protecting the liver and surrounding tissues against damage of any kind, and especially to avoiding injury to bile-ducts and blood-vessels.

Thus, with proper pre-operative and post-operative care, such as we have indicated, post-operative deaths of the "high temperature" liver death type can be avoided and the mortality of biliary-tract surgery definitely reduced.

#### CONCLUSIONS

(1) Traumatization of the ducts during gall-bladder operations may produce a fatal syndrome known as "liver death." The clinical picture is that of an overwhelming toxæmia not associated with jaundice.

(2) Fatal toxæmia of hepatic origin may occur after relatively simple operations, such as cholecystectomy, in patients considered good operative risks.

(3) By way of precaution, liver-function and blood-chemical tests should

always be performed pre-operatively. An unfavorable report should be considered a definite contra-indication to operation.

(4) During the course of the operation it is essential to be extremely gentle in handling the biliary ducts, as the slightest trauma may have a disturbing effect on hepatic function.

(5) One must constantly be on the watch for anomalous blood supply of the biliary tract, which is present in 25 per cent of cases. Injury to these vessels impairs liver functions because of the anatomical peculiarity of the blood supply of the liver.

(6) By observing special precautions prior to and during the operation, "liver death" can largely be avoided.

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# THE SYMPTOMS OF NON-CALCULOUS CHOLECYSTITIS IN THE ABSENCE OF COLIC THE SYNDROME OF CHRONIC CHOLECYSTITIS\*

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IF THE operation of cholecystectomy, as performed for non-calculous cholecystitis, is to justify its existence as a reliable surgical procedure, it would seem that the results should be at least as good as those secured with the same operation in calculous cases. Reports on this question from the leading surgical clinics of this country may be summarized as follows. Until recently, Judd,<sup>1</sup> in 300 operated cases, found that the end-results were better in the severer grades of cholecystitis, in stone cases, and in those patients who had suffered from colic, even in the absence of stones. With respect to the better results in colic, Judd<sup>2</sup> has recently reversed his opinion. From the Lahey Clinic Cattell<sup>3</sup> reported, in 634 cases, that the end-results were better in the calculous group. Deaver and Bortz,<sup>4</sup> in 903 cases, of which 50 per cent were calculous, secured equally good results in both groups, but their results (65.5 per cent), entirely relieved, are below the 87 per cent in Judd's selected group of strawberry cholecystitis with stones. Muller,<sup>5</sup> in sixty cases (exclusive of common-duct stone), found the results better in stone cases.

Inquiry into the numerous causes which underlie complaints following cholecystectomy will not be undertaken here. We have noted, in common with others,<sup>6</sup> that colitis is one of these causes. One seemingly extreme point of view may be mentioned. It is that chronic cholecystitis as found microscopically may not be of great significance, just as some surgeons now believe that a diagnosis of chronic appendicitis made microscopically is not of great significance. It is true that in many of the non-calculous cases the gall-bladder is thin-walled and semi-transparent, in contradistinction to the thick-walled organ so frequently associated with stones. This naturally leads to the question. Upon what should a diagnosis of chronic cholecystitis be based? The present study is concerned with symptomatology only. Cholecystographical findings have been reported elsewhere.<sup>7</sup>

That gall-stone colic is often preceded for years by dyspepsia has been claimed by Moynihan, Mayo-Robson, Bland-Sutton, and others. Dyspepsia has also been recognized as part of the picture of non-calculous cholecystitis, but clinicians have been reluctant to attach too much diagnostic importance to this dyspepsia, in the absence of other more characteristic symptoms. Moynihan<sup>8</sup> has, however, transferred his inaugural symptoms (early indiges-

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\* Read before the Southeast Branch of the Philadelphia County Medical Society, December 1, 1932.

tion preceding colic in calculous cases) to non-calculous cholecystitis Gibbon<sup>9</sup> thought that the "less typical symptoms" could be relied upon in diagnosis, if other factors were carefully controlled

*The Symptoms of Non-calculous Cholecystitis in the Absence of Colic*—A number of clinicians have described upper abdominal distress in the absence of colic Judd<sup>1</sup> implies that in addition to colic there are two kinds of dyspepsia (1) Indigestion in the sense of flatulence, belching, *etc*, and (2) "constant dull pain" Einhorn,<sup>10</sup> in contrasting acute with chronic cholecystitis, described the symptoms in the latter as "a repetition of the fullness and distress with increased severity and duration" Moynihan<sup>8</sup> said "briefly, the history is one in which there has been a period of indigestion lasting always for months, sometimes for years" Riesman<sup>11</sup> said that the symptoms were those of nervous dyspepsia Mason and Blackford<sup>12</sup> said three-fourths of their patients sought relief on account of "chronic gastric disturbances"

I have selected for study 180 cholecystectomized patients in whom microscopical examination showed chronic cholecystitis One-half were calculous cases The following were excluded Patients with chronic cholecystitis who showed acute or sub-acute appendicitis, acute cholecystitis and chronic suppurative cholecystitis, patients with hepatitis and pancreatitis as diagnosed by the surgeon; gastric retention, visceroptosis and ileal stasis if detected by X-ray examination, patients with jaundice if stones were not found at operation, patients with a history of diarrhoea, patients with spastic colon and constipation were not excluded

My observation of gall-bladder patients (in whom the diagnosis was confirmed at operation) has led me to believe that the dyspepsia from which they suffer is not as vague as we are sometimes taught, and that in their symptomatology there may be separated on the one hand such complaints as belching and heartburn ("simple indigestion") and on the other hand acute attacks of pain (biliary colic) from a rather definite syndrome which is neither and to which I attach the term "the syndrome of chronic cholecystitis"

The following six groups of symptoms in non-calculous cholecystitis are practical clinically, though they are based partly on pathology and partly on symptomatology They are (1) Syndrome of chronic cholecystitis, (2) attacks of biliary colic, (3) acute cholecystitis, (4) ulcer-like syndrome, (5) simple indigestion, (6) complications

(1) The syndrome of chronic cholecystitis (a) Distress in the upper abdomen, usually in the epigastrium, variously described by patients, (b) while the distress may be made worse by food, it is often uninfluenced by food (aside from the disagreement of fatty food) and not rarely lasts all day, even if little or no food is taken, (c) one of its most important characteristics is its total duration It commonly lasts for weeks—the average duration of an attack upon admission to the hospital was six weeks, (d) there is a marked tendency to recurrence of attacks, (e) if the patient is ill for a long enough time (average in this series four years) the pain will usually be referred (63 per cent in this series) (2) Attacks of biliary colic In patients suffer-

ing from gall-bladder disease an acute attack of pain, of greater or less severity, is usually ascribed to the presence of stone or to acute cholecystitis, or to some ill-defined reflex cause ("pylorospasm," *etc* ) Very severe pain may last for days, but I have also seen it last for weeks, a *status colicus* The differential diagnosis of these pains is difficult, which is another way of saying that a pre-operative diagnosis of stone in these cases is, from the symptomatic standpoint, rather unsatisfactory The actual incidence of biliary colic depends partly on the stage of the disease and the selection of patients for operation, but also partly on the interpretation of what constitutes biliary colic This accounts for the low incidence of 9.5 per cent of attacks of pain given by Deaver and Bortz<sup>4</sup> and the high incidence of "colic pains" of 70 per cent mentioned in Osler's *Modern Medicine*<sup>13</sup> and by others<sup>14</sup> In this series 35 per cent of patients (non-calculous) had acute attacks that might have been interpreted as biliary colic (3) Acute cholecystitis A good description of acute cholecystitis is given by Riesman<sup>11</sup> (4) Pain in relation to meals, "ulcer-like syndrome" 19 per cent of patients had pain which bore a definite relation to meals, but in only 7 per cent was this pain so unrelated to other symptoms that a diagnosis of ulcer was considered (5) "Indigestion," or "simple indigestion" This term appears necessary to designate such complaints as heartburn, belching, feeling of general abdominal distention, *etc* The feeling of a lump or distress in the epigastrium (or higher in the chest) occurring in so many conditions may be difficult to differentiate from the distress found in "the syndrome of chronic cholecystitis" Differential diagnosis cannot be entered into here, it is necessary to take into consideration the whole picture rather than any single symptom Patients with gall-bladder disease are subject to a great deal of "simple indigestion" In many of our patients this simple indigestion tended to disappear as the attacks of acute or chronic cholecystitis disappeared In 77 per cent of patients simple indigestion was the chief complaint on admission (6) Complications The incidence of jaundice, fever, *etc*, *etc*, need not be considered here

*Incidence of These Symptoms*—In the non-calculous group the syndrome of attacks of chronic cholecystitis occurred in 76 per cent of the group, but it must be made clear that this was often in combination with other symptoms A combination of chronic cholecystitis attacks and attacks of biliary colic (but not always at the same time) occurred in 23 per cent, attacks of chronic cholecystitis occurred alone (with the exception of simple indigestion which often accompanies an attack) in 42 per cent of patients

In the calculous group, on the other hand, the symptom which occurred most frequently by itself was biliary colic (53 per cent) with biliary colic occurring with various other combinations in 80 per cent of all calculous patients It is interesting to note that the "syndrome of chronic cholecystitis" occurred in 40 per cent of all stone patients

Two questions may be asked—first "What are the earliest symptoms?" In our histories in the stone group an attack of chronic cholecystitis was the

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first symptom in 23 per cent of the patients, but an attack of colic, without any obtainable history of previous indigestion, was the first symptom in 48 per cent. In the non-calculous group the first symptom was an attack of chronic cholecystitis in 50 per cent of the patients. Secondly "What per cent of patients suffering from such complaints as heartburn, belching, *etc* (so-called simple indigestion), have chronic cholecystitis as the cause of their complaints?" There is nothing in this study which answers this question. It may be noted that we obtained a history of "simple indigestion" only at the onset in 83 per cent of cases (as opposed to the above mentioned 50 per cent incidence of the "syndrome of chronic cholecystitis," i.e., "attack of chronic cholecystitis" at the onset).

*Comment*—Whether an "attack of chronic cholecystitis" be accepted as a syndrome will depend on several things (1) Whether it can be separated as an entity from the standpoint of its symptomatology, (2) whether it rests on a firm pathological basis. I have no further evidence to offer now. The syndrome may persist after cholecystectomy, but this is at least no more mysterious than the persistence for a time of biliary colic after the removal of a diseased gall-bladder and all stones. (3) Most important of all is the question whether this syndrome is relieved by operation at least as well as, let us say, biliary colic. I regret to say that my own follow-up is not large enough to be able to answer this question. I hope to have a larger follow-up in the future. I cannot urge this syndrome at present as an indication for surgery, although I think it corresponds to the inaugural symptoms of Moynihan, to the "Constant dull aching pain" of Judd, and in actual practice is used by many surgeons as an operative indication. In this respect I will quote the recent opinion of Judd and Priestley,<sup>2</sup> who said, "Patients with colic prior to *cholecystostomy* are likely to obtain more complete symptomatic relief than patients who complain chiefly of dyspepsia. The difference is not great, however, and after *cholecystectomy* it is even slightly reversed" [*Italics mine*]. If this be so, I think we have a powerful argument that the important factor in the "syndrome of chronic cholecystitis" is the diseased gall-bladder. This need not be taken as an indication for surgery by those who prefer medical treatment.

**CONCLUSION**—In non-calculous cholecystitis the commonest symptom is a fairly definite type of indigestion which I have termed the syndrome of chronic cholecystitis. This syndrome is described. It occurred (often together with other symptoms, such as biliary colic) in 76 per cent of ninety operated patients in whom the gall-bladder was examined microscopically.

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# PERFORATION OF THE GALL-BLADDER IN ACUTE CHOLECYSTITIS\*

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PERFORATION of the gall-bladder is unusual. It is comparable to perforation of any other viscus. The condition is most frequently confused, pre-operatively, with inflammation in a high-lying appendix, perforation of an ulcer of the stomach or duodenum, or acute pulmonary disease. However, an inflammatory process in the appendix may be so acute that it progresses to gangrene and perforation within a few hours. The gall-bladder rarely perforates during the first attack. Consequently, adhesions form, and when perforation does occur, the process usually remains localized about the viscus. Perforation in such a way that material runs free into the peritoneal cavity is rare, and when it does occur it constitutes a very difficult problem in accurate pre-operative diagnosis. In the majority of instances the true nature of the condition will not be revealed until the abdomen is opened and a bile-tinged exudate is found in the peritoneal cavity. Thick, œdematous walls may give the appearance of distention, but in reality the gall-bladder rarely bursts from overexpansion. Perforation is probably always due to ulceration or local gangrene of a part of the wall.

In reviewing the cases of acute cholecystitis in which operation has been performed at The Mayo Clinic in the last ten years, we found sixty-one in which the gall-bladder had perforated. In only two of these was there extravasation of content into the general peritoneal cavity. In the remaining fifty-nine cases the process was well localized. Forty-three of the patients were women and eighteen were men. The oldest patient was aged sixty-eight years and the youngest twenty-four, but by far the majority of patients were more than fifty years of age. That the accident tends to afflict older persons is in part because the blood supply to the organ is poorer with advancing years. When the process has been going on for some time and the function has been diminished, the chance of recovery is impaired while that of necrosis and leakage is increased.

All of the patients had had symptoms referable to the biliary tract. Eight had undergone cholecystostomy. Forty-eight had had acute symptoms previously. Some were in the midst of an acute attack when they arrived for consultation. However, the majority had gone through most of the acute symptoms before we saw them. The average duration of the attack before consultation at the clinic was fourteen days. The length of the period of

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observation depended on the condition of the patient, the average was six days, making the average time from the onset of the attack to operation twenty days. Colic was the chief and most common symptom, it was present in fifty-four cases. Sixteen of the patients had some degree of jaundice. Leucocytes numbered more than 10,000 in each cubic millimetre of blood in twenty-five cases, in seven of these, more than 20,000. Tenderness in the right upper abdominal quadrant was a constant finding. A mass could be felt in the region of the gall-bladder in twenty-seven instances.

Localized peritonitis was evident in all of the sixty-one cases. Gangrene in one or more areas of the wall of the gall-bladder was present in eleven cases at the time of cholecystectomy, and there was associated empyæma in twenty-two. Stones were found in the gall-bladder in fifty-six cases. They would be expected in a large proportion of cases, for acute cholecystitis without stones is uncommon. In the past it has been the general opinion that calculi in the common bile-duct are uncommonly coincident with a perforated gall-bladder. However, stones were found in the common bile-duct in nine of our sixty-one cases. It is possible that they were present at one time or another in a greater proportion of the cases, for many of the patients had had repeated attacks referable to the biliary tract.

The severity of the symptoms does not always indicate the extent of the pathological process, for in some instances it progresses to the stage of perforation and abscess without producing acute pain or other abdominal disturbance. The experience of one of the patients, a woman aged forty-three years, is typical. For two years she had had a "drawing feeling" in the epigastrium, moderate dyspepsia, and loss of appetite. One month before she came for consultation she had had generalized abdominal pain which had lasted an hour. It had been relieved by hot applications and once by vomiting. The woman never had been obliged to go to bed. With the exception of tenderness about the umbilicus, there was no indication of an abdominal pathological process. Analysis of gastric content disclosed that there was no free acid in the stomach. Two physicians were of the opinion that a cholecystic process might be present. At operation empyæma of the gall-bladder was found and it was evident that the gall-bladder had ruptured into the liver. Many stones were present. The appendix was involved in an inflammatory process. Cholecystectomy and appendectomy were performed. Two Penrose drains were used. Convalescence was uneventful.

Cholecystectomy was performed in forty-eight of the sixty-one cases with five deaths. cholecystostomy in thirteen with one death. Half of the deaths were associated with pulmonary complications. The coincidence of acute cholecystitis and pulmonary processes has been emphasized, undoubtedly the close proximity of the infected gall-bladder to the diaphragm is the predominant factor in this situation. Death is frequently attributed to the pulmonary complication.

Perforation of the wall of the gall-bladder, with leakage of the content into the abdominal cavity, is probably of more frequent occurrence than our

series indicates When the accident occurs the patient is too sick to travel, consequently the attending physician does not refer the patient to us but gives emergency attention at home Ordinarily we see only those patients who can be brought a short distance or whose condition undergoes acute exacerbation while they are en route to us for consultation

In reviewing the cases of acute cholecystic disease of the last ten years, in which the patients had died without having an operation on the gall-bladder, we found three in whom perforation of the viscus had occurred with ensuing general peritonitis The reason that surgical interference was not undertaken was that the patients were practically moribund on admission

In the two cases of our series in which perforation of the gall-bladder occurred in such a way that material ran free into the peritoneal cavity, one of the patients survived Immediate surgical intervention is imperative in such cases When the infection is localized an abscess forms This was the most common eventuality in our series The presence of a palpable mass in the upper right quadrant of the abdomen should arouse suspicion of the presence of the condition Cholecystostomy, or cholecystectomy with free drainage of the abscess, is indicated

Perforation into an adjacent viscus may occur This happened in seven of our sixty-one cases It resulted in six cholecystoduodenal fistulas and one cholecystocolonic fistula Because the gall-bladder and the duodenum are so intimately associated, it is difficult at times to determine whether a perforated duodenal ulcer has disseminated its infectious products into the gall-bladder, or whether the gall-bladder is the chief offender and has perforated into the duodenum Rupture through the abdominal wall was observed in two cases, in both of which previous operations on the gall-bladder had been performed In these cases, probably the viscus had been sutured to the abdominal wall at the time of the previous procedure or had become adherent in the scar

Even under the existing circumstances, the post-operative convalescence of some of these patients is smooth, apparently because vaccination against the infection has taken place, or because the primary condition was not the result of infection

# INCIDENTAL GALL-STONES IN WOMEN \*

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INCIDENTAL palpation of the gall-bladder during the course of an abdominal operation affords an exceptional opportunity to detect the presence of unsuspected gall-stones. This procedure, when methodically employed, will uncover the presence of gall-stones in a surprising proportion of the patients so examined. The existence of gall-stones having been established in a patient not suspected of possessing them before operation, one of several situations may be found to exist. It may happen that the usual symptoms of gall-stones have been present but were obscured by the complaints and findings associated with the condition for which the operation was performed, or were mistakenly attributed to this condition. Again, there may have been mild symptoms suggestive of gall-bladder disease not elicited in the history when taken, or if so, too vague and commonplace to convey their real significance. Or a revision of the patient's history may establish beyond question the fact that there has actually been a complete absence of the symptoms characteristic of gall-stones and that the stones have been truly quiescent and symptomless. While the medical profession has long been aware of the occasional existence of so-called silent or symptomless gall-stones, there is little available information as to the frequency of occurrence of such gall-stones or as to whether they are entirely symptomless to their possessors as assumed. Autopsies not infrequently reveal the presence of unsuspected gall-stones but when so found the opportunity for direct inquiry into past histories has passed by. Furthermore, statistics relative to gall-stones compiled from autopsy records cannot be regarded as entirely representative since they are commonly derived from institutions and too often based upon examination of aged, destitute and impoverished individuals. Nor can it be properly assumed in all cases that gall-stones unexpectedly discovered at autopsy have been truly quiescent or symptomless merely for the reason that so far as known they have never been a source of complaint. While the gall-stones discovered during the course of an abdominal operation may prove at times to have been actually symptomless, it is probable that in most instances they should be more correctly termed unsuspected. In cases where gall-stones have not been removed at the time of their discovery, or soon afterwards, knowledge of their presence will permit a prompt explanation of the lesser degrees of dyspepsia commonly associated with the onset of gall-bladder disease or in the absence of such symptoms afford opportunity to establish the duration of existence of quiescent or symptomless gall-stones.

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## INCIDENTAL GALL-STONES

Therefore, incidental examination of the gall-bladder and biliary passages by direct palpation during the course of an abdominal operation offers an exceptional opportunity to acquire valuable information as to the condition of these structures and to accumulate data as to the frequency of occurrence and behavior of unsuspected gall-stones

The report now presented is based upon an exploration of the gall-bladder during the course of 350 personal laparotomies (Table I), stones having been found present in thirty-one instances, or approximately 8.9 per cent. It has covered a period of ten years, is limited to women and is composed exclusively of cases in which the possibility of gall-bladder disease had not been considered in the pre-operative diagnosis. The examination of the gall-bladder has been a routine procedure in all cases where this might be done without detriment to the welfare of the patient. The attempt was made to avoid anything approaching a selection of cases, the data being compiled as opportunity permitted in the ordinary course of routine operative work.

TABLE I

*Three Hundred Fifty Cases in Which the Gall-bladder Was Examined by Palpation During Operation, Grouped by Decades and Showing Incidence of Occurrence of Gall-stones*

Decade	10-19	20-29	30-39	40-49	50-59	60-69	Totals
Gall-bladders explored	3	82	146	91	21	7	350
Stones present	0	6	8	12	4	1	31
Approximate percentage of occurrence of stones	0	7.3	5.5	13	19	14	9.8

While it is not intended to maintain that thirty-one out of 350 women possessed silent or symptomless gall-stones, it can be stated that gall-stones were found present in thirty-one women in whom it had not been expected to find them before operation. It is obvious, in retrospect, that this number was somewhat augmented either by defects in history-taking or inattention to the details of a fairly comprehensive history or both, and by imperfect diagnosis in general, with the result that certain cases were thus included in the group under discussion that might otherwise have been eliminated.

At first impression, a percentage of nearly 9 per cent might be regarded as unduly high. However, as the investigation was limited to women, the great majority of whom had borne children and most of whom were in the period of life contributing the highest incidence of gall-bladder disease, a rather high percentage of occurrence should be anticipated. Furthermore, there is good reason to assume that of the 350 women examined, probably more than thirty-one were actually the victims of gall-stones. Gall-stones too small to be palpated through the gall-bladder wall, particularly a gall-bladder wall thickened by disease, have naturally escaped detection. A few small gall-stones, even of palpable size, very readily elude the touch in a distended or partly distended gall-bladder, while a small, smooth stone located in the mouth of the cystic duct is sometimes difficult to apprehend, the more

so through a lower abdominal incision. In a number of cases inflammatory adhesions were encountered in the region of the gall-bladder, no stones apparently being present, not all of which could be properly ascribed to duodenal or gastric disease. For these reasons it would seem proper to assume that the incidence of gall-stones among the 350 cases examined was actually in excess of 9 per cent and the incidence of biliary disease even substantially higher.

The thirty-one women in whom gall-stones were discovered constituted a particularly interesting group for analysis and further observation. All but four were or had been married, and twenty-three gave a history of one or more pregnancies, the great majority of multiple pregnancies. Six were in their third decade of life and eight in their fourth. Thus, fourteen in all, or almost one-half, were under forty years of age. Seven were colored women, five of these being operated upon for uterine fibroids and two for large ovarian cysts. Of the twenty-four others, seven were operated upon for fibrous or fibroid uterus, four for ovarian cysts, three for uterine displacements, and two for conditions of the tubes. Thus, twenty-three of the thirty-one women possessing stones were recruited from gynecological cases. Six operations were classed as exploratory laparotomies, three of these proving to be cancer, and two were for the repair of ventral hernias. Four of the thirty-one gave a history of having had typhoid fever, seventeen a history of never having had this disease, while ten were not questioned in this regard.

The thirty-one cases fall rather naturally into three general groups, first, those whose gall-stones were dealt with at the time they were discovered, second, those who have had a subsequent cholecystectomy, and finally, a group of those that have not had as yet, for one reason or another, further surgical treatment.

In the first group, comprising six patients, five cholecystectomies were immediately performed, conditions indicating the operation at the time. In the other, a small, friable and solitary stone was removed by cholecystotomy, a procedure regarded with even less enthusiasm after its accomplishment than before it was undertaken. That an immediate cholecystectomy was not performed more frequently where stones had been discovered was due to what seemed adequate contra-indication at the time. In no case had gall-bladder disease been a consideration before operation or been discussed with the patient in advance. In a good many instances treatment of the primary condition had already imposed sufficient drain upon the patient's vital resources. The mortality rate for cholecystectomy alone ranging as high as 3 per cent and perhaps being equally high for the particular operation then in prospect, it was felt that the mortality and morbidity for the combined procedures would inevitably prove to be more than twice that of either operation performed separately. As an incision for a gynecological condition had been made in a great majority of the cases, an inadvisable extension of this incision would thus have been necessary to deal with the gall-bladder, and

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perhaps even with this no more than an unsatisfactory exploration of the biliary system afforded. The very great importance of performing an adequate operation in all cases of gall-bladder disease at the first attack was also prominently in mind and proved a restraining influence.

Two cholecystectomies were performed as a result of an exploratory laparotomy based upon indefinite, but persistent pain in the right lower quadrant, doubtfully attributed to chronic appendicitis. Possible gall-bladder disease had not been considered, probably for the reason that both patients were well below the age that might suggest the presence of this condition. Both were completely relieved of their symptoms. In three cases the gall-stones, and not the gynaecological conditions for which the operation had been undertaken, explained the outstanding symptoms and made possible their cure. In the case of the sixth patient whose gall-stone was removed by cholecystotomy from an apparently normal gall-bladder, there were clear-cut symptoms of bile leakage post-operatively. Three layers of fine sutures did not satisfactorily close the incision through the delicate gall-bladder wall, and it would appear preferable to drain, remove or leave alone a gall-bladder under such conditions. Two and a half years after this questionable procedure the patient can be reported as in good general health, having gained in weight and being free from pain or digestive symptoms. Whether this particular gall-bladder known to have contained a stone and to have been emptied will reproduce others remains to be seen.

Five patients constitute the second group of those whose gall-bladders were removed at a later operation. It was not unnatural that patients in whom gall-stones were discovered and not dealt with at the time did not receive the information of their condition with uniform enthusiasm. A few were stolidly indifferent, some incredulous, others apparently merely annoyed, and one, of an emotional nature, declared herself committed to suicide, as such an additional misfortune was more than human nature could support. One woman, twenty-nine years of age, proved an outstanding exception by welcoming the information as explaining a persistent indigestion for which she had been under recent treatment. She returned for the removal of her gall-bladder three months later, with most satisfactory results. Another who asserted her disbelief in the announcement that she had gall-stones was brought to the hospital twenty months later in a severe attack of biliary colic and requested immediate operation. One went for two years in apparent good health, and then after two years of misery submitted to operation, four years after the discovery of her stones. The fourth had been operated upon for a fairly large fibroid uterus, the only complaints having been the presence of the tumor and some pressure symptoms. Three months afterward she reported the onset of occasional attacks of indigestion, still later excessive gas and pain under the right shoulder-blade, and with constant aggravation of her symptoms, precipitated by food, she resorted to partial starvation, losing much weight. Her gall-bladder was removed twenty-two months after the discovery of her solitary stone which had obviously increased somewhat.



in size by accretion during the interval, with complete relief of her symptoms and a very considerable increase in weight. The fifth patient, twenty-two years of age, was followed for almost seven years with great interest. For five years she had almost constant digestive complaints, that might have been satisfactorily explained on the basis of her highly irregular habits. It was not possible under the circumstances to ascribe her symptoms entirely to gall-stones, nor would she contemplate an operation. However, her dyspepsia ultimately passed into typical and increasingly severe attacks of biliary colic, and she finally submitted willingly to cholecystectomy six years and ten months after the discovery of her stones.

The third group is composed of those patients who have not been operated upon for their gall-stones, twenty in all, or nearly two-thirds of the entire number found to possess stones. Four of these patients were rather promptly eliminated by death from other causes, one of these known never to have had biliary symptoms, the other three having died without opportunity for investigation of their past histories following operation. Another was neither seen nor heard from following her departure from the hospital. Eight of the twenty were followed for periods of from three months to five years and then lost. Seven have continued under more or less constant observation up to the present time. Two of the eight eventually lost were having suggestive complaints when last interviewed, another severe attacks, while five were in good health when last reported. One of these, a colored woman, followed for five years, and without symptoms, was repeatedly urged to have her gall-stones removed, but concluded the interview with the remark, "Why bother them if they don't bother me." Of the seven still under observation one has digestive complaints not readily dissociated from her gall-stones a year after their discovery. Another patient, found to have stones nine years ago, had a single mild attack of biliary colic five years later, this being the only manifestation of the presence of her gall-stones during this entire period. Two others have been free from all symptoms for periods of five years each, and one for more than three and a half years. The two remaining have been symptom-free for periods of two years and a year and a half, respectively.

Of the thirty-one women, therefore, who were unexpectedly found to have gall-stones among the 350 examined, four are dead, one was immediately lost and eleven have been relieved of their gall-stones, while of fifteen still possessing their stones four are having symptoms, or were when last seen, and eleven are symptom-free, or were when last seen.

A list of thirty-one women found to possess gall-stones at operation who had not been suspected of possessing them beforehand should afford a most favorable opportunity to establish satisfactorily the existence of one or more possible instances of silent or symptomless gall-stones.

Since two of the five symptom-free cases lost sight of had proven themselves such for periods of three and five years, respectively, before disappearing, and since of the six symptom-free cases still being followed one

has had but a single slight attack during a period of nine years and two no manifestations during five years or more, it might seem justifiable to somewhat arbitrarily classify these five as possible instances of silent or symptomless gall-stones, in the commonly accepted meaning of the term. If so, they would represent but 1.4 per cent of the 350 women in the series examined, a group that excluded all patients suspected of possessing biliary disease.

If it is demonstrable that gall-stones may lie dormant for considerable periods of time following the discovery of their presence, there is good reason to believe that they may also do so following their incipency. This being the case, there is support for the belief that the acute symptoms of biliary disease so commonly met with during middle life are but a late manifestation of gall-stones long present, and that gall-bladder disease more frequently dates its origin from the earlier years of life than has been generally recognized.

The relation of typhoid fever to this group of cases and especially to the cases found to have gall-stones was of considerable interest. One hundred thirty-one of the 350 patients were questioned with some care as to whether they had had this disease, and nine, or about 7 per cent, of the questioned cases replied in the affirmative. Among the 122 patients who had not had typhoid fever there were seventeen with gall-stones, or an incidence of almost 14 per cent. Of the thirty-one women possessing gall-stones, twenty-one were questioned as to typhoid fever and of the twenty-one so questioned four had had typhoid, representing a scant 20 per cent of the stone cases questioned as to typhoid. It should be noted that five of the patients who had had typhoid did not have stones.

Coincident ventral hernia and gall-bladder disease present a special problem. While a small umbilical hernia may be repaired without invasion of the area affording surgical approach to the gall-bladder, the larger umbilical hernias and hernias following incisions through the right rectus sheath are preferably not repaired over a gall-bladder containing stones. Unexpected attacks of acute biliary colic occur at times during convalescence from operations for ventral hernia, forecasting the probable necessity of an operation upon the gall-bladder at a later time, and the re-incision of an abdominal wall extensively and tediously reconstructed. It would seem particularly appropriate to examine carefully into the condition of the gall-bladder before engaging upon any extensive operation for the repair of a ventral hernia. If gall-stones are found present, the gall-bladder may be removed, drainage established through the flank and the repair of the anterior abdominal wall proceeded with, thus eliminating the possibility of either a flare-up of an overlooked complication or a later re-incision of the reconstructed abdominal wall.

While the material herewith presented may be insufficient to establish the percentage of occurrence of unsuspected gall-stones in women, even approximately, or to make a material contribution to the problem of the so-called symptomless variety, it may serve to re-emphasize certain elemen-

tary and supposedly familiar facts not infrequently escaping merited consideration Gall-bladder disease, with or without stones, must be accepted as an exceedingly common affliction among women, particularly among women who have borne children, and not infrequently dates from the latter part of the second decade of life It would seem that one or more pregnancies in the very young become a direct agency in, or at least almost inseparable from, the premature development of gall-stones Among women known to possess gall-stones, a certain percentage will be found apparently exempt from symptoms, or at least so for considerable periods of time Eventually, however, the great majority of stones may be depended upon to actively assert their presence by the development of more or less typical symptoms While a routine exploration of the gall-bladder is not by any means advocated, it certainly should not be omitted during the course of an abdominal operation when the welfare of the patient will permit With satisfactory relaxation the fingers can follow along and at the same time slightly elevate the anterior abdominal wall until the free edge of the liver and the gall-bladder are encountered, with but slight reflex disturbance

Familiarity with the palpation of the gall-bladder will develop the sense of touch and so greatly facilitate the detection of such stones present as are palpable It will also develop an increasing confidence in the opinion formed as to the condition of the gall-bladder and biliary passages based upon palpation only Information thus obtained will commonly prove of very great value to the patient, serving at once to explain the past, direct present procedure or anticipate future developments Omission of this procedure, on the other hand, where it might readily have been carried out, may operate to the disadvantage of the patient at some later time A patient, more or less promptly, following an abdominal operation, may develop symptoms highly suggestive of gall-bladder disease When by careful palpation the gall-bladder and ducts have given every evidence of being normal, there will be greater caution in determining upon a diagnosis of gall-bladder disease and resort to an operation upon this organ

While it would seem that so-called silent or symptomless gall-stones do occur and must be accepted as a reality, they should be regarded as a decided exception to the general rule

# SUCCESSFUL RESECTION OF THE COMMON BILIARY DUCT FOR CARCINOMA OF THE AMPULLA OF VATER \*

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PRIMARY carcinoma of the bile-ducts, and particularly the terminal portion of the common duct, is not so rare as is commonly believed. When found at operation, however, the lesion has often become so extensive, with infiltration of the pancreas and surrounding structures, that the origin of the neoplasm remains obscure. Biopsy of tumors involving the head of the pancreas and the common duct is impracticable, and it is probable that many lesions, diagnosed even at operation as carcinoma of the head of the pancreas, and treated by palliation, have their origin in the lower part of the common duct.

Pertinent reports indicate a considerable difference of opinion regarding the incidence of malignancy in the biliary system. In material from The Mayo Clinic over a twenty-year period, Marshall<sup>8</sup> found only forty-nine primary carcinomata of the extrahepatic bile-ducts and four cases of benign tumors. Judd and Gray<sup>5</sup> found in 312 operations for malignancy of the gall-bladder and bile-ducts that the former was more than twice as common as the latter, 212 carcinomata being primary in the gall-bladder and 100 primary in the bile-ducts.

Kelnack<sup>7</sup> found only two cases of primary carcinoma of the bile passages in 4,578 autopsies and McGlenn<sup>9</sup> reported only five instances in 9,000 autopsies indicating a relatively infrequent occurrence of this lesion. Shapiro and Lifvendahl,<sup>11</sup> however, found twelve cases of carcinoma of the extrahepatic bile-ducts comprising 3.7 per cent of all carcinomata in 2,500 autopsies. This was twice as frequent as carcinoma of the gall-bladder and three times as common as carcinoma of the pancreas. The usual clinical diagnosis in their cases was cancer of the pancreas.

In 4,544 autopsies at the University Hospital the incidence of carcinoma of the extrahepatic biliary tract and pancreas was as follows: ten, or 2.2 per cent, were primary in the gall-bladder; eighteen, or 3.9 per cent, were of the pancreas; and eighteen, or 3.9 per cent, were in the extrahepatic bile-ducts. In the latter group thirteen occurred in the region of the papilla or terminal portion of the common duct, four were thought to be primary in the cystic duct, and one arose from the hepatic duct. From these data it is readily seen that carcinoma of the bile-ducts is not a rare lesion and that this may be the correct diagnosis as often as carcinoma of the pancreas, in a suspected neoplasm producing jaundice. Furthermore, the common

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\* Read before the Detroit Academy of Surgery, April 13, 1933

clinical diagnosis of carcinoma of the head of the pancreas is very often proven incorrect by pathological study To illustrate One group of fifteen cases had a clinical diagnosis, before operation, of cancer of the pancreas Of these, six died without operation and the diagnosis shown by autopsy was in one, stone, in two, carcinoma of the pancreas involving the body and tail respectively, and in three the lesion was primary in the bile-ducts In nine cases operated upon, with subsequent autopsy (except two cases reported below), the pathological diagnosis was carcinoma of the pancreas in one case, carcinoma of the gall-ladder in two instances, and carcinoma primary in the bile-ducts in six The clinical diagnosis of carcinoma of the pancreas was correct, therefore, in 20 per cent, while in 60 per cent the growth was in the bile-ducts

In addition, three cases with carcinoma of the common duct, found at autopsy, had been variously diagnosed as carcinoma of the stomach or gall-bladder, carcinoma of the stomach with liver metastases, and common-duct stone In two other cases, in which carcinoma of the pancreas was found at autopsy, the clinical diagnosis in each had been carcinoma of the colon

In many cases, the origin of the carcinoma in the biliary tract is of academic interest only, since the lesion is so widespread that only palliative treatment for the relief of icterus is possible In some instances, however, the obstructing lesion is small, and were it thought to be primary in the common duct rather than in the pancreas, an attempt at extirpation of the growth would be justifiable and occasionally practicable The difficulties in diagnosis of carcinoma of the common duct, even at operation, are fully recognized It would appear advisable, however, in the presence of a small growth, where there is any doubt regarding the origin, to open the duodenum for inspection of the papilla and probing of the terminal portion of the common duct Should radical operation then prove to be impracticable the opening in the duodenum may be used for a palliative anastomosis with the gall-bladder

Transduodenal resection of carcinoma of the ampulla of Vater or lower part of the common duct is not a common procedure and new cases successfully operated upon with the expectancy of cure probably deserve recording Halsted<sup>4</sup> reported the first operation of this sort, in which the ampulla and two centimetres of the common duct were resected, with reimplantation of the common and pancreatic ducts, and cholecystduodenostomy The patient lived nine months Cohen and Colp<sup>2</sup> reviewed the reported cases in 1927 and found fifty-nine radical operations for carcinoma of the peri-ampullary region Transduodenal resection was done in fifty-three, with a mortality of 44 per cent Walters,<sup>12</sup> reporting a case operated upon by him in 1931, mentions several previous reports, as well as four unpublished cases from The Mayo Clinic, two of which survived the operation Pemberton's<sup>10</sup> case died two years after operation from metastases, and Judd's<sup>6</sup> patient, operated upon in 1928, required further operation one year later for biliary obstruction

To the above cases, I wish to add three from the Department of Surgery

# CARCINOMA AMPULLA OF VATER

Fig. 1. Papilliferous adenocarcinoma of the terminal portion of the common duct arising in a benign papilloma. Inset shows the site of infiltration and the extension of the papillary lymphatic in the duct.



Fig. 2. Showing reimplantation of the common and pancreatic ducts with the tubes *in situ* after excision of the lower portion of the common duct. The duodenum was closed to itself.



of the University of Michigan, in which a transduodenal resection of the common duct was done for carcinoma of the ampulla of Vater Cabot,<sup>1</sup> in 1925, resected the lower end of the common duct for a robin's-egg-sized carcinoma, in a man thirty-five, and reimplanted the duct in the duodenum. He reoperated upon the patient four years later for chronic empyæma of the gall-bladder, at that time felt the tube which had been left extending from the common duct into the duodenum, and left it undisturbed. A recent check-up of the patient (February 17, 1933) shows him to be in good health, free of symptoms and without having had a recurrence of jaundice. After this eight-year period it is probably safe to assume that he is past the danger of metastasis and should be considered undoubtedly cured. Coller,<sup>3</sup> in 1928, did a similar resection of the common duct in a sixty-four-year-old male. Death occurred on the fourth post-operative day from cholæmia and inanition. An autopsy was not permitted.

The third case, recently operated upon by the writer, is reported below. Mrs F T, No 309,029, aged fifty-seven, housewife, entered the hospital February 28, 1933, complaining of epigastric pain and jaundice. The onset of the illness was three months prior to admission when she noticed a dull, gnawing pain in the epigastrium with no relation to food. The pain was intermittent and was relieved by vomiting. It had remained about the same but the vomiting had become more frequent. Two weeks prior to admission the patient noticed jaundice which was persistent and progressive and associated with light-colored fatty stools and dark brown urine. The patient had lost twenty pounds' weight in four months. She was emaciated and presented deep icterus. The abdomen was scaphoid and the liver edge was at the level of the umbilicus. A smooth, rounded mass was felt under the liver edge which was thought to be the gall-bladder. The remainder of the physical findings were unimportant. The hæmoglobin was 66 per cent, the red blood-count 3,800,000, the urine was negative except for the presence of bile and the blood bilirubin 40 mg/1000 cc with a direct reaction. X-ray studies were negative except for non-visualization of the gall-bladder. A diagnosis was made of carcinoma of the head of the pancreas.

*Operation*—March 6, 1933. Upon opening the abdomen, the stomach and first portion of the duodenum appeared normal, the liver was considerably enlarged although not unusual in appearance, the gall-bladder was thin walled, about three times normal size and contained unconcentrated bile, some of which was aspirated, the cystic and common ducts were greatly dilated, there was no evidence of stone in either the gall-bladder or the ducts. The obstruction was then thought to be in the distal portion of the common duct and palpation through the duodenum revealed a firm, hard mass in the region of the head of the pancreas. This mass was about 3.5 centimetres long and 2 centimetres in diameter, and lacked the fixation usually encountered in carcinoma of the pancreas. No glands suggesting metastases were felt. The possibility of the neoplasm arising in the ampulla of Vater was then considered, and direct inspection was thought to be essential. The duodenum was therefore opened by a longitudinal incision on the anterior surface of the second portion after ascertaining that a cholecyst-duodenostomy would be feasible if extirpation of the growth was not possible.

The region of the ampulla was occupied by the mass which had been felt, and presented an ulcerated area about two centimetres in diameter on the posterior duodenal mucosa. The posterior wall of the duodenum with the mass was lifted anteriorly with little difficulty, and about three centimetres of the terminal portion of the common duct dissected free, including a cuff of duodenal mucosa 0.5 centimetre wide around the ulcerated area. The duct was anchored by stay sutures through the cut duodenal wall.

## CARCINOMA AMPULLA OF VATER

before it was divided and inspection showed that the resection was well above the infiltrating part of the growth, although it had extended upward some distance in the duct as a polypoid tumor. The dilated end of the pancreatic duct was found just below and medial to the common duct, and was reimplanted with the latter in the posterior wall of the duodenum. Two small tubes, 2.5 centimetres in length, were inserted in the common and pancreatic ducts, and held by fine sutures to the duct walls and the duodenal mucosa. There was an immediate copious flow of bile and pancreatic secretion. The anterior wall of the duodenum was closed transversely in three layers to enlarge its lumen at this point.

The pathological report by Dr. C. V. Weller was: "At the most distal part of the common duct, there is extreme polypoid hyperplasia of the mucosa of the duct with carcinomatous infiltration at the base. Slightly higher the section shows very extensive infiltration with adeno-carcinoma surrounding the duct and invading the duodenal muscle. The most marked carcinomatous infiltration is present at about one-quarter inch above the opening of the ampulla." The opinion of the pathologists was that the neoplasm had probably started as a benign papilloma, with malignant degeneration and infiltration at the base, comparable to papillomatous growths occurring in the rectum.

The patient made a rapid and uneventful convalescence with prompt diminution in the icterus and a fall in blood bilirubin to 8 mg/1000 cc within three weeks. On discharge from the hospital on the thirty-first post-operative day she had gained ten pounds in weight and felt perfectly well.

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# CYSTICODUODENOSTOMY \*

AN EXPERIMENTAL STUDY

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CONSIDERABLE advance has been made in the surgery of the biliary ducts during the past thirty years, but the technical difficulties encountered have restricted success to a few well-trained masters of detail and operative skill

Numerous methods for the transplantation or implantation of the ducts have been suggested Most of these procedures are either time-consuming, difficult to perform, or give poor results The procedure to be described is

simple, easy to carry out, rapid, and so far, has given excellent results The most difficult operation on the biliary tract involves the anastomosis of the hepatic ducts with the duodenum following a stricture just proximal to the entrance of the cystic duct The exact reduplication of this operation is impossible in the dog because of the different anatomical arrangement of the biliary tract Normally there is no single hepatic duct in the dog One or two tributaries enter the common duct distal to the entrance of the cystic duct Since a hepatoduodenostomy cannot be done on this experimental animal, the common duct is doubly ligated and divided, the gall-bladder is removed, and the stump of the cystic duct is cannulated and anastomosed with the duodenum The cystic duct in the dog is

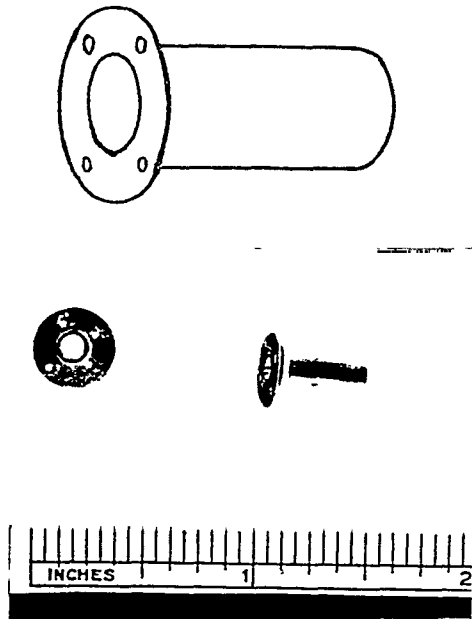


FIG 1—Line drawing and photograph of actual cannula with scale to indicate size

from one to two centimetres in length and very close to the liver, and so the technical difficulties encountered in performing an anastomosis of this duct with the duodenum will be quite comparable with those involved in executing a hepatoduodenostomy

*Procedure*—The accompanying figures illustrate the procedure The common duct is isolated, doubly ligated distal to the point of entrance of the hepatic ducts and divided between the ligatures The gall-bladder is removed, and the stump of the cystic duct is cannulated onto a specially constructed silver cannula (Fig 1) The cannula is retained

\* This study was aided by a grant from the Fluid Research Fund of the Rockefeller Foundation

## CYSTICODUODENOSTOMY

by two medium silk sutures placed in the wall of the duct on opposite sides and about three millimetres from the end, each thread passing first through a hole in the flange of the cannula, then through the wall of the duct, and finally back through an adjacent hole in the flange to be tied. One thread of each of these sutures is cut, while the other end is preserved for later use as a traction suture. A circular tie of fine black silk is placed around the duct just behind the flange of the cannula. Since dogs do not tolerate intra-peritoneal bile, the region is protected with moist gauze against soiling. Without mobilizing the duodenum an appropriate site is selected for the introduction of the cannula.

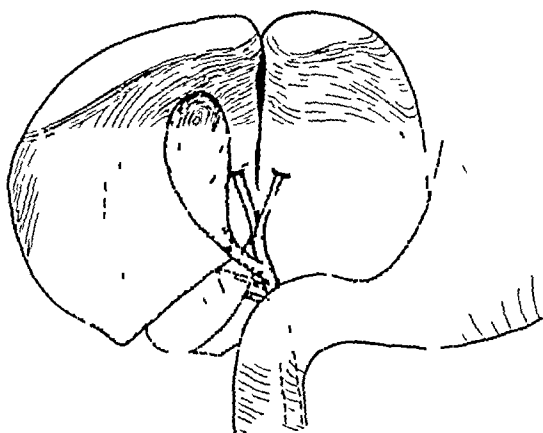


FIG 2

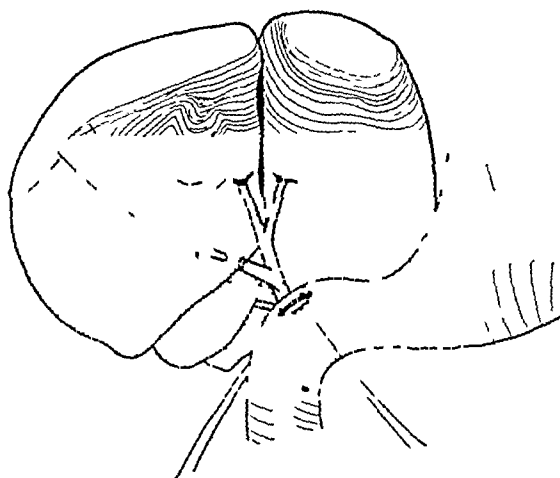


FIG 3

FIG 2—Illustrating the normal anatomical arrangement of the biliary ducts in the dog. Hepatic ducts enter the common duct distal to the cystic duct of the gall bladder.

FIG 3—The gall bladder has been removed, the common duct has been ligated and divided, and the duodenum has been incised after the purse string sutures have been placed. The method of cannulating the cystic duct with the special, silver cannula is demonstrated.

and duct, and two purse-string sutures are placed in the wall of the viscus. An inner suture of linen and an outer purse-string of medium black silk are placed as indicated in FIG 3. A longitudinal opening is made through the duodenum just long enough to admit

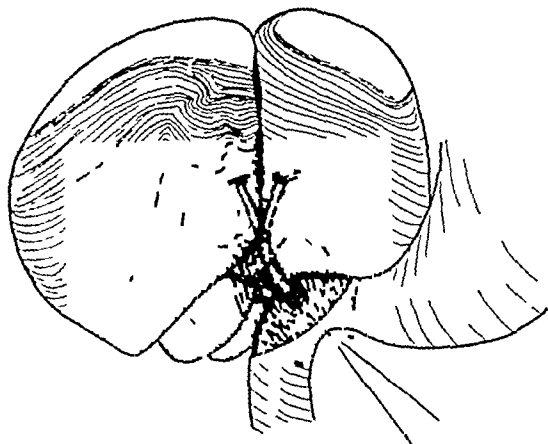


FIG 4

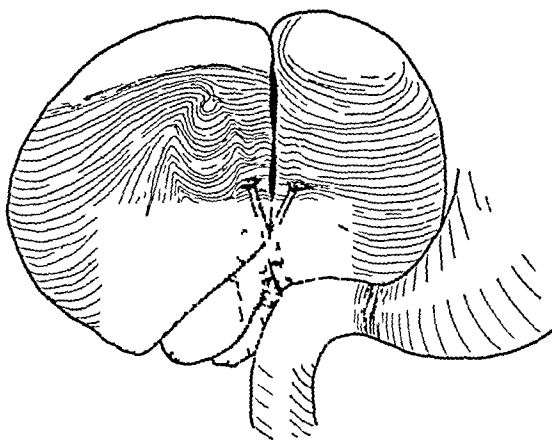


FIG 5

FIG 4—A section of the duodenum is removed to show the cannula and cystic duct in place after tying both purse string sutures. The traction sutures are still in place.

FIG 5—This shows the completed operation without having the duodenum sutured to the capsule of the liver, which can be done readily when the liver is permitted to assume its normal position.

the cannula and duct easily. The two traction sutures on the cannula are threaded onto a single calyx-eyed needle and passed into the duodenum through the incision and then through the opposite wall of the viscus. These sutures are to be drawn up so as to haul the cannula and biliary duct into place.

With the cannula in place the inner purse-string is pulled up and tied under full tension just behind the flange of the cannula. The second purse-string suture is tied with a minimum of tension. After inspecting the closure the traction sutures are cut short and

allowed to retract into the lumen of the bowel. The liver will readily move down against the duodenum, and a suture may be placed to secure the bowel to the capsule of the liver. No attempt is made to seal off this region from the rest of the abdominal cavity. The abdomen is closed.

*Discussion*—Once the details of the entire technic were established, no post-operative complications were encountered in a sufficient series of dogs to show that the procedure was free from uncontrollable defects. All of the animals ate well on the day following operation. After five months none has developed jaundice or shown any other evidence of biliary obstruction. They have all gained weight and appear to be entirely normal dogs.

The metal cannulae were observed fluoroscopically and were discharged into the lumen of the bowel anywhere from five to forty-two days post-operatively. The cannula insures free drainage throughout the post-operative course and, at the same time, permits the inner purse-string suture to be tied under full tension. While the duct is held in place by the flange on the cannula, tension at the healing surfaces is determined by the second purse-string suture. Microscopical sections show healing to be well advanced by the fourth post-operative day. Since no sutures are placed after the duodenum and biliary duct are approximated, it is possible to perfect an anastomosis easily when as little as one centimetre length of duct is available.

The operative procedure is rapid, requires little surgical skill, and has been successfully applied to the transplantation of pancreatic ducts and ureters, also.

The many helpful suggestions of Dr. Emile Holman are gratefully acknowledged.

**SUMMARY**—(1) A simple, rapid technic is described for anastomosing small ducts into a larger, hollow viscus.

(2) Cysticoduodenostomy by this method is described in detail.

(3) No post-operative complications were encountered.

# SPONTANEOUS EXTERNAL RUPTURE OF EMPYEMA OF THE GALL-BLADDER

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THERE have been, to my knowledge, but seven cases of external perforations of the gall-bladder reported in modern literature<sup>1-7</sup> In 1890, Courvoisier reported 196 cases of external perforations of the gall-bladder, but was himself doubtful of the veracity of the records McCay's case is the only other besides the present one that made use of iodinized oil in making the diagnosis

The present case is a white woman, aged forty-two, and married Her chief complaint on presenting herself to the Out-patient Department of Bellevue Hospital, in December, 1932, was a painful swelling in the right upper quadrant of two months' duration



FIG 1 —External fistula of the gall bladder

Family History irrelevant, except that her mother died at the age of seventy-two with jaundice and was told she had a growth in the liver, a brother is living but has had gall-bladder attacks for the past nine years

*Past History*—She has had two children one now nineteen and the other fifteen years of age When twenty-nine years of age she was subjected to a panhysterectomy for fibroids of the uterus At this time she was told that she had a stone in the gall-bladder, although she had had no gall-bladder symptoms Her weight was 208 pounds Following the operation, she enjoyed excellent health for seven years, until 1927, when the present illness began, characterized by indigestion, belching of gas, and pain in the region of the gall-bladder, and at times pain radiating to the right shoulder and back With the first gall-stone colic attack in 1927, she had a well-marked jaundice which lasted for two weeks In 1928, one year later, she experienced a second gall-stone colic attack, but had no

associated jaundice with it. The third attack was one year later, in 1929. The fourth attack was in January, 1931. After this she had attacks every three weeks until she entered Bellevue Hospital February 9, 1933.

In October, 1932, the patient first noticed a swelling in the region of the gall-bladder. She stated that this seemed to appear all at once and was very sore and painful.

February 8, 1933, while at home, the skin over the mass ruptured and a great quantity of greenish pus was evacuated. This gave considerable relief and the discharge gradually became thinner.

February 9, 1933, she entered Bellevue Hospital under my supervision. She had a draining sinus in the right upper abdominal quadrant and complained of a dull, aching pain in that region. Temperature was 100°, pulse 80 and respiration 20.

The Graham Test failed to show visualization of the gall-bladder. A Lyon's drainage done February 10, 1933, showed that there were no cholesterol crystals, no bilirubin calcium, and no concentrated bile. Lipiodol was injected into the sinus tract and X-ray examination made, which showed a tract running up toward the region of the gall-bladder and partially outlining it. The following night, three medium-sized gall-stones were passed through this sinus.

It was, therefore, deemed wise to excise the tract, and because of the infected area, a cholecystostomy, rather than a cholecystectomy, was done. The operation revealed a small gall-bladder well up under the liver, packed with stones. These stones were removed and a drainage tube placed in the gall-bladder. The patient made an uneventful recovery.

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# THE INDICATIONS FOR AND RESULTS OF REMOVAL OF THE SPLEEN

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UNTIL recently the surgery of the spleen was chiefly concerned with rupture and the rarer forms of tumors and cysts. It is only within the last twenty to thirty years that it has been appreciated that the spleen is not only affected in many general disorders but may be the most important factor, so that its removal is followed by a cure or by marked amelioration of the symptoms.

That splenectomy is often the sole means of treatment for severe hæmorrhage following a rupture, for torsion, for localized cysts and for some benign tumors is today generally acknowledged, and the indications for operation in such cases may therefore be regarded as absolute. It is also known that after such an operation there may be a secondary anæmia, a leucocytosis, a lymphocytosis, an eosinophilia and a thrombocythæmia, but such changes are as a rule transient and of but little moment. Beyond the danger of post-operative thrombosis following on such an operation, I can find no account of any ill effects due to splenectomy.

It is in the group of diffuse splenomegalies that the indications are less clear and the results of operation less well defined. It will usually be found most convenient to consider such cases from the point of view of the individual function of the spleen which may be disordered rather than from a consideration of the underlying pathological changes, and therefore to group them under the following headings.

*Alterations in the Spleen's Function as a Reservoir* — Dating from the work of Barcroft and Binet, it is realized that one of the chief functions of the spleen is to store up large quantities of blood for periods of emergency. In cases of infection, and especially those infections where some protozoon is present in the blood-stream, the organism may be stored up in the spleen which thus acts as a focus for reinfection. Splenomegaly is common in all cases of malaria, and kala-azar and less frequently with syphilis and tuberculosis. In some such the disease tends to become chronic and fails to yield to the ordinary forms of treatment but after splenectomy has been performed a good recovery follows. I have previously reported a case of this nature where a physician aged forty-six years had had malaria when thirteen, but never since. One week previously he had awakened and feeling his abdomen discovered an enlarged spleen. After careful blood examination he was regarded as a case of splenic anæmia and I then performed a splenectomy. The spleen was very large, weighing  $4\frac{1}{2}$  pounds. Fifteen days after operation several benign tertian parasites were discovered in the blood and on the twen-

tieth and twenty-third days he had two typical attacks of malaria. The symptoms yielded to suitable medical treatment and he has since remained perfectly well. It is probable that in his case the malarial parasites had been stored up in his spleen for many years and a splenectomy was necessary to cure him of the infection.

Sir Humphrey Rolleston, especially, has directed attention to the occasional necessity of performing a splenectomy in resistant cases of congenital syphilis. In tuberculosis the disease is as a rule less localized but the spleen may be the chief focus and a splenectomy thus give a better chance of a radical cure.

*Errors in the Splenic Action upon Normal Red Blood-corpuscles*—Although it is realized that in foetal life the spleen is one of the factories of red blood-corpuscles and that even in adult life a secondary anæmia may follow splenectomy, it is but rare that this function is stimulated and that a polycythæmia results. Thursfield has laid stress upon the fact that this may sometimes happen with tuberculosis of the spleen in children between the ages of six and twelve. As a general rule, however, polycythæmia appears rather to be dependent upon a diminution in the spleen's function of destroying red blood-corpuscles and thus a splenectomy is not indicated. The more frequent error appears to be that the spleen destroys the red corpuscles to an excessive degree and there is a large group of disorders which is characterized by splenomegaly and an anæmia of the secondary type. So little is known of the anatomy of the spleen that there is considerable doubt as to the true nature of the underlying pathology in these conditions. In some there is a cirrhosis of the liver which appears to be the primary change, in others there is thrombosis of the portal and splenic veins, in yet others occlusion of the ostia of the hepatic veins (Chiari's disease), while in the remainder the condition of the spleen is believed to be primary (Banti's disease), somewhat allied with this group is von Jaksch's disease of young children.

Owing to the lack of knowledge of the underlying pathology, the classification of this group has to depend very largely upon the clinical picture. There is in the earlier stages a secondary anæmia with splenomegaly which may persist for ten or more years. Later the liver enlarges and in the third stage it becomes small and shrunken and ascites supervenes. With the anæmia there is generally a leucopenia and a relative lymphocytosis. In the majority severe hæmorrhage may occur, especially from the stomach. This clear-cut clinical picture may be caused not only by different underlying pathological conditions, but it is also difficult—indeed, if not impossible—to say which is the primary pathological change. Thus, a primary cirrhosis of the liver will cause back pressure upon the splenic vein and so cause an enlarged spleen, which is often somewhat fibrous and may contain Gandy-Gamna nodules. But the conditions which are often regarded as primarily splenic and are described as splenic anæmias may progress not only to a cirrhosis of the liver but even in their early stages a microscopical examination of the liver will usually reveal the presence of a portal fibrosis. In the same way, thrombosis of the portal or splenic veins may lead to venous pressure upon the spleen but a

splenectomy for a primary splenomegaly may be followed by a thrombocythæmia and thus a thrombosis ensue which discovered post-mortem is regarded as a primary change

There are thus many who believe that there is no such thing as a primary splenic anæmia or Banti's disease, but that it is always secondary to cirrhosis of the liver or venous obstruction. On the other hand Gibson has many supporters in his view that the primary lesion is an inflammation of the spleen and that the abnormal products coming from this organ have led to the cirrhosis of liver, the thrombosis of the vessels and other changes. So much is this so that certain surgeons have advocated splenectomy for all cases of cirrhosis of the liver.

There can be no doubt that this group does include many diverse lesions and it therefore becomes a very difficult matter indeed to state dogmatically what are the indications and results of splenectomy in these cases. In my own series of forty-eight splenectomies fourteen were grouped as splenic anæmias and four as splenomegaly secondary to cirrhosis of the liver. Those regarded as primary splenic anæmias showed twelve recoveries with good end-results. Two having advanced cirrhosis of the liver died two years later, but of the rest one is alive and well for ten, one for eight, one for five, one for three years and the remainder for shorter periods after operation. Those regarded as due to a primary cirrhosis of the liver showed only two recoveries and even with them the end-results were not satisfactory, one having died a year later and one having to be treated also a year later for recurrence of the ascites. It is therefore in this group that very careful thought must be given to the diagnosis and to the indications for surgical treatment.

*Diseases Due to the Splenic Action upon Abnormal Cells*—There is a certain group of diseases in which the blood-corpuscles are at fault but are apparently capable of filling the requirements of the body. The spleen, however, appears unable to recognize their value and, since they are not up to standard, destroys them; hence this otherwise normal function becomes a serious menace to the patient's life. These diseases are pernicious or primary anæmia, acholuric or familial jaundice and thrombocytopenic purpura. To-day we as surgeons are little if at all concerned with the group of primary anæmias. It is now recognized that owing to the absence of a gastric ferment the ingested proteid is not converted into a substance which stimulates the development of the megaloblast. These cells, being unable to develop, proliferate, but being immature, are destroyed by the spleen. The results of treatment of these patients by the administration either of the necessary ferment in the form of raw hog's stomach or by the prepared product in the form of liver has led to such satisfactory results that a splenectomy rarely if ever is necessary. It is, however, my belief that occasionally a case occurs in which the destructive effect of the spleen is so marked that satisfactory progress will be much aided by a splenectomy combined with correct medical treatment. Such cases, however, will probably be very rare.

One of the most interesting diseases of the spleen and the one in which



splenectomy gives the most satisfactory results is acholuric jaundice. In this disease the patient is as a rule born with red blood-corpuscles which are abnormal in shape and especially in fragility. They are thus destroyed by the spleen so that jaundice and a profound secondary anæmia develop. Owing to the increase of pigment in the blood-stream, gall-stones of the pigment type are almost certain to occur.

The pathological and clinical details of this interesting disease have recently been discussed so fully and admirably by Lord Dawson that there is no need for me to describe them. There can be no doubt that in these cases a splenectomy is definitely indicated and should be performed before the patient's life has been endangered by the resulting anæmia. Fortunately, these spleens, though often of very considerable size, rarely show any secondary inflammation and thus the mortality from operation is relatively low. In Giffin's eighty-one cases, for instance, the mortality was only 4.9 per cent. In my own seven cases of splenectomy performed for this disease there has been one death. They have made relatively good progress, two being alive and well, eleven and five years later.

A similar function of the spleen in destroying the blood-platelets instead of the red blood-corpuscles is probably the explanation of thrombocytopenic purpura. It is now recognized that the old clinical classification of the different types of purpura no longer holds good and that many of the varieties which were at one time regarded as simple may now pass on to the more progressive types. Although purpura may occur as a symptom in practically any form of severe toxæmia, there is a well-recognized type which is characterized by (*a*) a low platelet count, (*b*) a prolonged bleeding time, (*c*) failure of the blood-clot to retract, (*d*) a normal clotting time and (*e*) the appearance of petechiæ below a tourniquet. The disease may occur in acute and chronic forms and may be found at any age and apparently in either sex. The chronic cases in young boys may be clinically mistaken for hæmophilia but are at once distinguished by the blood characteristics for in hæmophilia the platelet count is normal and the clotting time is greatly prolonged.

The reason why in this disease the blood-platelets are destroyed by the spleen is not certain but it would appear that for some reason they are thrown into the circulation in an immature condition and thus are not accepted by the splenic apparatus. What is the cause of this production in an immature state is open to doubt, but my own belief is that it is due to some infection which acts directly upon the platelets and not upon the capillary wall, as has been believed. My own experience has been that not only may purpura occur with practically any form of toxæmia but that these particular cases are associated with pyrexia in the early stages and that at this period the spleen is not yet enlarged. Should an operation be undertaken during the early and acute stages the mortality is very high, but if carried out when the patient has recovered from the evidence of toxæmia and when the spleen is enlarged, showing that the low platelet count is in large part dependent upon the over-

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activity of the spleen, then the splenectomy is likely to be followed by a complete cure

Tidy has laid stress upon the fact that a leucocyte count is of great value, for if it is low not only is this evidence that the bone-marrow is becoming aplastic but the relative lymphocytosis may lead to confusion with lymphatic leukæmia. Therefore, in these cases not only is it important to make very certain of the diagnosis in the early stages, but, wherever possible, the patient should be carried over this dangerous period before a splenectomy is performed. It is my own custom whenever possible to wait until there is a definite decrease in the platelet count. That this view is correct must, I think, be accepted, for Whipple found that in eight cases operated upon in the acute stages there were seven deaths, whereas in seventy-three chronic cases there were only six deaths.

If the operation be performed in the chronic stage it is true that now and again mild degrees of purpura may follow, but as a general rule the patients make a completely satisfactory and happy recovery.

*Metabolic Changes in the Spleen*—There is a certain group of diseases in which the enlargement of the spleen occurs only as a part of a general metabolic change. These cases are rare and consist of three somewhat closely allied conditions known as Gaucher's disease, Niemann-Pick disease and hypercholesterinæmia. These three conditions which are characterized by an excess of blood cholesterol and an excess of either kerosin or cholesterol in certain cells of the body, including those of the spleen, are due to a general metabolic error and therefore splenectomy cannot produce a cure. It may, however, in the more chronic varieties such as Gaucher's disease give considerable palliation in that it may overcome an accompanying thrombocytopenia and give great relief from the pain and discomfort due to the enlarged spleen. One of the most remarkable cases of this sort with which I am acquainted is the patient who has been reported by Hunter and Evans, where the splenectomy was performed by Sherren and the patient was alive and well thirteen years later, although she still showed the characteristic bronzing of the skin, the conjunctival thickenings and enlargement of the liver.

*Errors in the Splenic Action upon Leucocytes*—As a general rule, neither the formation of lymphocytes nor of leucocytes is entirely limited to the splenic tissue. Lymphatic and splenomedullary leucocythæmias are therefore not likely to be cured by splenectomy, an operation which, in these diseases, is associated with a high mortality. Nevertheless, cases occur in which the operation appears to give a marked degree of relief. Thus, one patient of mine who was regarded as a chronic myeloid leukæmia is alive and relatively well seven years after splenectomy, although her blood still shows the presence of normoblasts and myelocytes. It is an operation, however, which should be reserved for exceptional cases.

*Chronic Granulomatous Lesions*—In this group, which includes Hodgkin's disease and the so-called lymphosarcomatosis, the spleen is widely affected but is only a part of what is probably a diffuse inflammation, and

there is therefore no reason to believe that a splenectomy will help in any way towards an abatement of the general change. The danger lies in that some of these cases are often mistaken for splenic anæmia but it has been my experience that if at operation the lymphatic glands are found to be enlarged the prognosis is likely to be bad. In others, a positive diagnosis is made only after the splenectomy has been performed and a section of the viscus then shows a large number of ill-defined spherical areas, apparently due to the greatly enlarged Malpighian bodies. Such cases are likely to do badly and it can generally be accepted that if a splenomegaly is associated with a general lymphatic enlargement the prognosis will be grave and a splenectomy is unlikely to be of any value.

# PILONIDAL CYST, ITS ETIOLOGY AND TREATMENT\*

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ALL SURGEONS have had to endure the embarrassment of having patients return once or twice with a discharging sinus after a most thorough and extensive operation for pilonidal cyst. It seems impossible that after such a wide dissection, extending to the periosteum of the sacrum and coccyx, and an excision of the tissues even in front of the coccyx, that a remnant of the original cyst wall could have escaped. Yet this has happened so commonly, even among the most meticulous operators that we are forced to acknowledge that we must be in error as regards the origin and location of this condition, with its resultant inadequate treatment. All writers agree that complete excision of the wall of the cyst or of the sinus tract will cure the condition. In principle, this is undoubtedly true, and its corollary must be equally true, that if a cure has not been established, it must be that all the cyst wall or sinus wall has not been removed. It also seems highly improbable that during the past fifty years, surgeons of undisputed skill and thoroughness would continually overlook portions of cyst wall or sinus tract, in the face of the well known fact that their recurrence is so frequent, in the soft parts of the caudal end. We are forced, therefore, to look further than the soft parts for the origin of these cysts and sinus tracts. Statistical data is not very great on the percentage of recurrence, but in a recent paper by Cattell and Stoller,<sup>4</sup> who report fifty patients operated upon, of whom forty were followed, twenty had been operated on one or more times before and of the forty, there were nine who suffered recurrences, one of which was operated upon a second time. It is conservative to say that recurrence in the best hands is between 25 and 35 per cent. J K Anderson<sup>1</sup> reports operating upon twenty cases, 50 per cent having been operated upon before. Landsman<sup>9</sup> conservatively states that 20 per cent required repeated operations.

It would seem proper to discuss first the group under discussion from the standpoint of classification, as there is great confusion in this matter. We are to consider those conditions called pilonidal cyst, sinus, dimple and sacrococcygeal dermoid. These are found on the dorsum of the sacrum and coccyx and only because of their great size may find their way in front of the sacrum or coccyx. It is not the purpose to discuss in this paper those which are found in front of the sacrum or coccyx, the origin of which I believe is totally different from that of those found on the dorsum. As we find in pilonidal cysts and sinuses epithelial cells lining the walls of the tract or cyst cavity, they must necessarily be derived from cells derived partly, at least, from the embryologic ectodermic layer. It is also a fact that those epithelial

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derivatives not characteristic of epithelium of this location, such as teeth or nails, are not found in true pilonidal cysts. This, therefore, would make us think less of the thought that these cysts may be the product of embryonal rests from other distant parts. This type of tumor may be found along the post-anal region, where teratomas are frequently found, but these should not be confused with true pilonidal cysts. We must go back therefore and study more carefully the development of the caudal end of the embryo.

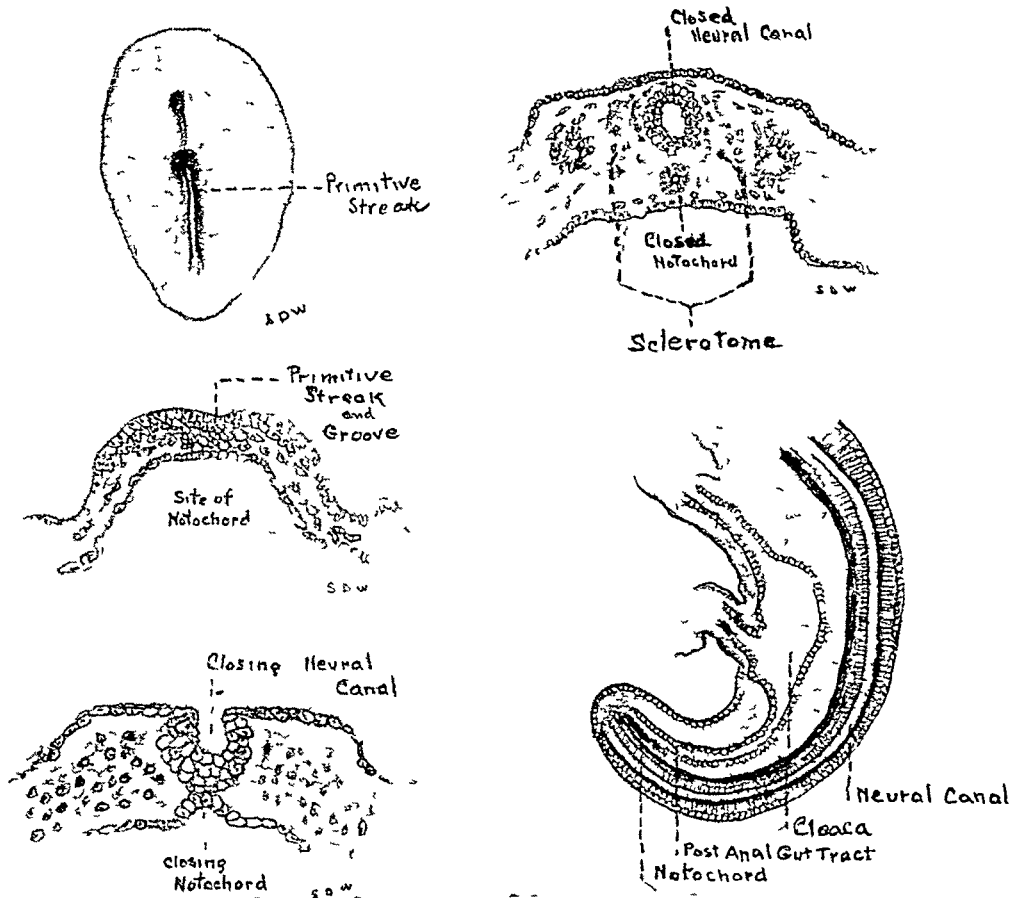


FIG 1—(A) Embryonal area of rabbit about eight days showing the primitive streak. (B) Cross section showing primitive streak, beginning formation of primitive groove and the site of the notochord. (C) Cross section of closing neural canal and formation of notochord, rabbit embryo of about nine days. (D) Cross section showing closed neural canal, notochord and developing sclerotome of rabbit embryo of about nine and a half days. (E) Sagittal section of caudal extremity of cat embryo of 6 mm showing the neural canal patulous to the tip of the primitive coccyx.

At about the third or fourth day there appears in the human germ in the long axis of the embryonal area what is called the primitive streak, containing a medium furrow, the primitive groove. This surface marking in cross-section is shown to be due to a thickening of the ectoderm in the mid-line. Some authorities believe the primitive streak of the human embryo to be the elongated blastopore of lower forms having a gastrula. They also believe that the opening of the neurenteric canal is the blastopore of those lower forms. At this point, therefore, there is a close association and transition between ectodermic and entodermic layers. At about the fourteenth day in the human germ in the mesial portion along the long axis, the medullary plate is laid down, made up of ectodermic cells. These cells curl laterally to form the medullary groove, the lips of which finally meet to form the medullary or neural tube or canal, the fundament of the

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brain and spinal cord (Fig 1) The curling begins in the forward area of the embryo, and progresses toward the caudal end and necessarily includes the primitive streak As the lips of the medullary groove fuse, the ectoderm spreads itself over the finally closed medullary canal Proceeding concurrently with the development of the medullary canal is the formation of the notochord Cells derived from the entoderm invaginate dorsad, fuse and form a tube the position of which corresponds to the centre of the future vertebral bodies Derived from the mesodermic layer is the sclerotome, which lies adjacent to the notochord and neural canal It is made up of connective tissue cells and is often designated as the skeletogenous sheath or membranous primordial vertebral column It is from the sclerotome that the vertebræ are derived Extending dorsad the arches surround the neural tube and fuse dorsal to the tube As the vertebrae develop, the notochord becomes less and less marked, until in the human it disappears

The processes described extend to the tip of the coccyx, the neural tube being patulous to the tip of the primitive coccyx (it will be noted that the filum terminale of the spinal cord is attached to the last piece of the coccyx in the adult human) The formation of the notochord and vertebræ with their dorsal arches are, at first, identical, later, fusion occurs to form the sacrum and coccyx The spinal cord occupies the entire canal until the third month of foetal life The process of obliteration of the neural canal, Mallory<sup>11</sup> states, takes place at first and most completely at the lower end of the sacrum, and extends from this point in both directions The obliteration of the canal between the end of the vertebral column and skin frequently takes place in an irregular manner, and the medullary canal in the cord shows frequent irregularities, sometimes existing as a distinct canal, sometimes double and often showing in sections as a very irregular clump of cells At the third foetal month, the cord occupies the entire length of the canal By birth, the more rapid lengthening of the spine causes the cord to be drawn upward to about the level of the third lumbar vertebra The dura extends at birth to the second sacral vertebra, and the filum terminale is attached to the last piece of the coccyx Quain<sup>10</sup> points out that the spinal portion of the medullary canal retains a uniform cylindrical shape, excepting toward the caudal extremity, where it is longer in being formed, and remains for a time a flat, open rhomboidal dilatation

Mallory<sup>11</sup> described his findings after examining the caudal extremity of six foetuses between the ages of three and six months He found frequently a canal lined with epithelium over the coccyx, in some cases connected with the skin, in some near the skin and in others near the coccyx If due to an extension inward of the skin, he argues, or as Lannelongue<sup>10</sup> assumes, to the skin being bound down to the coccyx, why do they not contain the glands and hair follicles with which the epidermis in that region is studded? Torok<sup>20</sup> attempts to answer that question when he attaches importance to the date at which pathological ectodermal inclusion occurs He believes that a very early inclusion means the isolation of ectoderm, the cells of which are completely potential, and are therefore capable of the formation of hair and glandular appendages Inclusion at a later date involving cells, the function of which is already determined, uni-potential, simple cutaneous cells, means that the walls of the epidermoid cyst are composed of one or more layers of flattened epithelium Mallory<sup>11</sup> further argues that if these sinuses are an extension inward of the skin, why do they occur here so often and nowhere else? This statement is not quite true, as dermoids of the scalp, the inner angle of the orbit and pharynx have a very frequent communication with the cranial dura through the suture lines This suggests an analogous condition to that of sacro-coccygeal dermoids, cysts and sinuses Mallory<sup>11</sup> concludes, however, "that it is much more likely that they (pilonidal cysts and sinuses) are due to incomplete obliteration of a former canal and extending as they do upward and toward the coccyx, the medullary canal seems the most likely origin" He further points out that branchial clefts close by the eighth week of foetal life, and the obliteration of the medullary canal at about the same time, with the difference that the growth is more rapid and perfect in the upper part of the body and hence, more favorable to closure of the clefts, and as sinuses and cysts occur

in the neck, there is at least an equal chance that they may occur in the lower end of the medullary canal

Oehlecker,<sup>16</sup> quoted by Cattell and Stoller, finds "that the cauda appears first in the three millimetre embryo and at twelve millimetres its reduction already takes place. It begins by the disappearance at first of the lower three or four caudal vertebræ. At this stage there is recognized a vertebral and non-vertebral portion. The non-vertebral portion is known as the caudal ligament or filament. This is a connective tissue prolongation of the caudal vertebræ, and is mesodermic in origin. The caudal vertebræ next begin to grow rapidly, and the overlying skin being unable to keep up with the downward growth of the vertebral column is displaced posteriorly and upward, as is also the tip of the caudal ligament. By the fourth or fifth month the skin, which originally covered the tip of the coccyx, is drawn upward so as to lie over the third or fourth caudal vertebra and later goes higher. The point where the caudal ligament radiates into the skin, makes a very thin, hairless vascular area, which he calls the sacral bald spot of the embryo. The radiations of the caudal ligament exert a certain pull on the overlying skin, and a depression or fistula is formed. The caudal vestiges of the spinal cord form a small epithelial lined space with many recesses and sinuses. The remnants of these which continue to grow by themselves are said at times to give rise to so-called dermoid fistulæ and cysts in the sacral region, but these are very rare. The skin over the area (the sacral bald spot) is extremely thin and vascular and without hair." If one finds hair in such a fistula, he believes it due to the presence of adjacent dermoid cyst or fistulæ. If this be the true explanation, it would be difficult to explain the direction that pilonidal sinus tracts take which all writers on the subject speak of and that is upward and toward the sacrum or coccyx. The tug on the skin, however, may explain the presence of the furrow or cleft which occurs in normal individuals directly over the sacro-coccygeal joint. It varies in depth from a superficial dimple to a cleft one-quarter of an inch deep. Tait<sup>17</sup> declared the dimple to be "an hereditary cicatrix of the spina-bifida by which the human tail has been lost." He found a dimple in 23 per cent of the women he examined in Birmingham Hospital for Women. Lannelongue<sup>18</sup> described a conical cicatricial depression observed in one out of four or five cases in children at the tip of the coccyx. He gives the following explanation "after the medullary canal is formed, the mesoblast passes back between the vertebral column and external epidermis, except in the region of the sacrum where little of this tissue is interposed, so that this region is reduced to epidermis and bone. Consequently, the superficial layer joined at a later period to the mesoblast preserves closer relations with the bone and at one or more points the skin may be bound down to the bone and later, when subcutaneous tissue is developed around these places, a depression will be formed. If deep and narrow enough, the orifice may be closed up and a dermoid cyst be the consequence."

Harvey B. Stone<sup>18</sup> in his paper on the origin of pilonidal cyst, stated that he was impressed with the similarity in position and development of the preen gland or oil gland found in a great many species of birds. He refers to the studies by Lunghetti, Paris and Schumaker. He described the preen gland as being imbedded in the subcutaneous fat over the last caudal vertebrae. It consists of numerous straight tubules lined by polyhedral epithelial cells some with granular cytoplasm, these tubules converging until they finally empty by way of an epithelial lined duct on to the skin of the back. The ducts may number from one to six, lying near the mid-line. He concludes that this hereditary tendency to form an invagination may possibly be the impulse stimulating these cells to sequestration as found in pilonidal cyst or sinus.

Simple invagination of the epiderm, partial or complete, with an incidence of traumatism cause pilonidal cyst to exhibit itself is the view held by Dulligan.<sup>5</sup>

Masson<sup>12</sup> quotes Bland-Sutton who states that "faulty coalescence of the cutaneous coverings of the body" is the cause of pilonidal cysts and sinus "such recesses are

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lined with pilose skin and contain sebaceous and sweat glands, and if the external openings become occluded without the deeper parts being obliterated, we would have the germ of a dermoid"

Bookman<sup>2</sup> explains them as being due to displacement of dermal or dermoid cells in the embryo which are lost during the process of fusion in the mid-line and then assume an abnormal location under the skin, the products of skin metabolism accumulate, forming a cyst

Warren,<sup>21</sup> who first described the condition in 1867, claimed it to be a change of the growth of hair follicles in the region

Mummery<sup>14</sup> stated it to be an exaggeration of the post-anal-dimple and that they are sequestration dermoids. Anderson,<sup>1</sup> quotes Bevan and Drusck, who describe the condition in much the same manner. Anderson also adds that they occur in between 60 and 80 per cent in males and among hairy individuals

Other interesting explanations have been given. Gross<sup>7</sup> called them "polycystic congenital tumors arising from a sebaceous follicle which during development intercepts a small tuft of hair"

It is obvious that if the various theories claiming the origin of these cysts to be captured ectodermic cells regardless of the manner in which they are caught and grow in the subcutaneous tissue and soft parts, there is no reason why, with careful bloc dissection, at least 100 per cent of cures should not be obtained. To be sure, some such explanation may account for the cures that are obtained, but a more concise interpretation, dependent upon one principle of faulty development is the more likely, that is to say, that during the formation of the medullary canal there is included from the ectoderm a group of cells that may or may not be continuous with the medullary canal after complete development. That this inclusion may occur early or late, involving completely potential or uni-potential cells, that the fusion of the dorsal arches of the vertebra may proceed normally, excluding from the medullary canal any inclusion cells or capturing them within the medullary canal, or, that the normal fusion of the dorsal arches does not occur, resulting in spina bifida occulta, and an unobliterated portion of the medullary canal anywhere below the level of the second sacral vertebra, which unobliterated portion may communicate directly with the skin forming a sinus, or not open upon the skin, forming a cyst, being either in communication with a sac of inclusion cells completely potential or uni-potential or exist separate from such cells

It is obvious that if this faulty development involves only an inclusion of certain cells of ectodermic origin, which do not communicate with the medullary canal and are dorsal to the vertebral arches, and that the medullary canal has become completely obliterated, a simple bloc dissection of the soft parts would cure these cases. But in about 30 per cent or more cases, the process is not so simple

Many writers have reported cases of spina bifida with a dermoid resting in the defect of the dorsal arches of the vertebrae

Fraser<sup>8</sup> reports a very interesting case of a dermoid found lying in the posterior median fissure of the cord. It was easily enucleated and had no communication with



the cord. It was found at the level of the ninth thoracic segment. The cyst wall was lined with a basement membrane with several layers of epithelium, no glands or hair follicles being present. The contents were pultaceous and composed of fat, cholesterol and round glistening friable bodies formed by the concentric deposition of epidermoid flakes and degenerated cells, characteristics which gave the contents an appearance resembling that of cholesteatoma. In his discussion he quotes Torok<sup>20</sup> in laying emphasis on the inclusion of completely potential or uni-potential cells of the ectoderm and recalls the varied situations and depths of cysts of this type—extradural, intradural, pial, intramedullary and intraependymal, believing that the variations in depth supported the hypothesis that there is a distinction in the time incident at which these cysts originate.

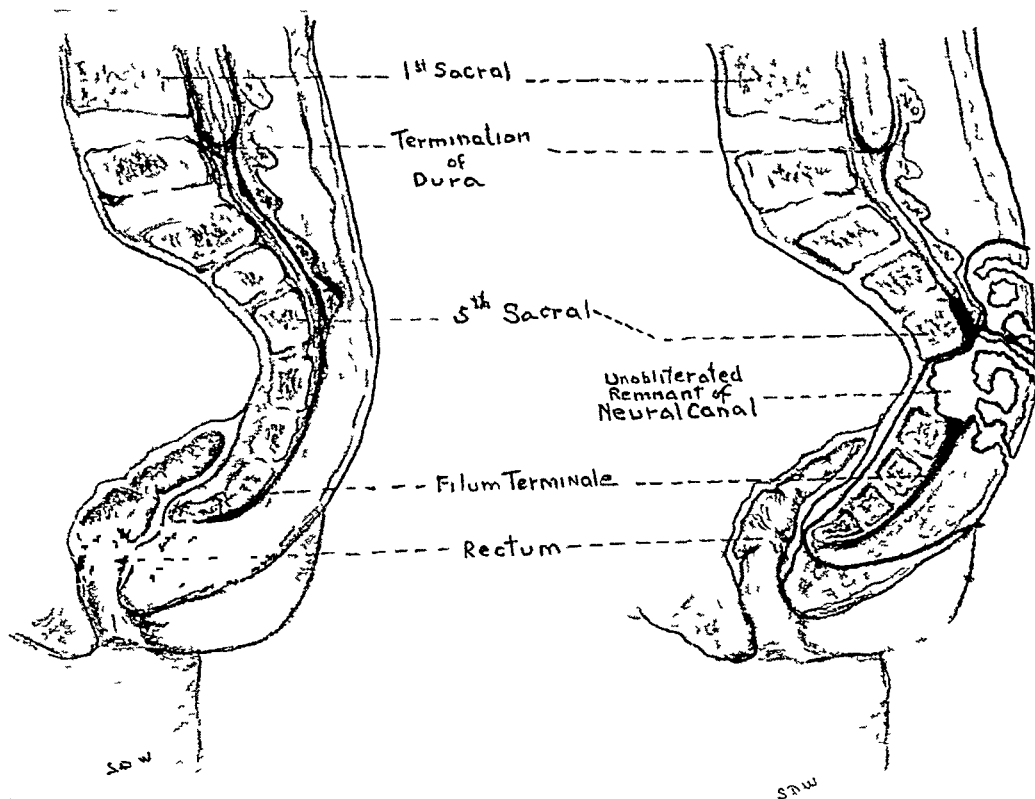


FIG. 2—(A) Sagittal section of normal caudal end showing dura obliterated at the level of the second sacral vertebra, the hiatus sacralis and the filum terminale attached to the last piece of the coccyx. (B) Sagittal section of the caudal end showing the various types of pilonidal cysts and sinuses, the upper three do not communicate with an unobliterated portion of the neural canal requiring only excision of the soft parts, the lower three communicate with an unobliterated portion of the neural canal requiring cleaning of the sacral hiatus and excision of the coccyx. (The sacrococcygeal joint has been widened for the purpose of illustration.)

He quotes Verebelley's case as a demonstration of this point—a boy fifteen years of age showed two cysts, extradural in position, one typically dermoid in structure, the other lined with embryonal neuro-epithelium, a canal unlined by epithelium connecting the two cavities.

In Fraser's<sup>9</sup> case we have an inclusion of ectodermic cells within the normally fused dorsal arches.

Ripley and Thompson<sup>12</sup> reported a case of pilonidal sinus as a route of infection in a case of staphylococcus meningitis. This occurred in a child three and one-half months old. The second sacral arch was deficient. A sinus tract led from the skin to a sac over the second sacral vertebra, which contained hair and sebaceous material. The base of the sac communicated with the spinal canal. This was verified at autopsy.

Moise<sup>13</sup> also reported a case of staphylococcus meningitis secondary to a congenital

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sacral sinus This occurred in a boy eighteen years old The sinus situated over the upper end of the sacrum communicated with the spinal canal and had been present from birth, discharging intermittently a watery fluid The X-ray examination showed a sacralization of the fifth lumbar vertebra, an irregularity in the fusion of the spines of the fifth lumbar and first sacral and a flattening of the spine of the first sacral segment with a defect below this level At operation, the sinus was injected with methylene blue and found to communicate with the spinal canal The sinus extended through a small bony defect just to the right of the mid-line at the junction of the first and second sacral vertebræ The dura was opened and found to be stained with methylene blue The microscopic examination showed the sinus tract to be lined with several layers of stratified squamous epithelium surrounded by a dense fibrous wall He enlarged the sinus opening by doing a laminectomy for better drainage of the spinal canal, and his patient recovered He supports Mallory in his belief that pilonidal sinuses result from unobliterated portions of the medullary canal In Ripley and Thompson's<sup>17</sup> case we have an inclusion of completely potential cells forming a dermoid opening on the skin and communicating with the spinal canal through an unobliterated opening of the primitive medullary canal through a spina bifida occulta and other developmental errors in the bony parts (Fig 2) In Moise's<sup>13</sup> case, we have a sinus communicating with the spinal canal passing through a spina bifida occulta and opening upon the skin, the cells lining the tract being uni-potential and a part of the unobliterated primitive medullary canal

It would seem justifiable then to conclude that in most cases of pilonidal sinus, cyst, dermoid or dimple, that recur after a bloc dissection of the soft parts, that there is a part of the cyst wall contained within the bony parts, that it is an unobliterated portion of the medullary canal and that as obliteration of the medullary canal begins at the lower end of the sacrum the unobliterated portion will be below the last piece of the sacrum and will, in all probability, be at the sacro-coccygeal junction It is therefore now suggested that in those cases of pilonidal cyst, sinus, dermoid or dimple, that recur, that excision of the coccyx with careful cleaning of the sacral hiatus will remove the remnant of cyst or sinus wall and result in a complete cure

*Review and description*—It will be noted frequently in a carefully injected pilonidal sinus with methylene blue that when the sinus tract is traced to the bone there will be seen a discoloration at the sacro-coccygeal joint which seems to extend beneath the surface of the bone Weinstein<sup>22</sup> in the January, 1933, issue of ANNALS OF SURGERY in reviewing the subject of pilonidal cyst stated that in some cases it was necessary to remove the periosteum from the dorsum of the sacrum and coccyx at the sacro-coccygeal region

Much information the writer believes may be obtained by injecting some solution opaque to X-rays into the sinus tract and making X-ray plates Brams<sup>3</sup> recommended this and reports a case he X-rayed after injecting the sinus tract with lipiodol

Three cases of pilonidal cyst unoperated before have been operated by the writer in all of which the injection of methylene blue showed a discoloration of the bone at the sacro-coccygeal joint and excision of the coccyx has been done There has not been a recurrence in any of the three, one after a year and a half, the second one year, and the third six months after operation A fourth case operated upon four times before was operated upon in

January, 1933, with excision of the coccyx Since then the wounds have healed favorably

The operative technic followed was to inject the sinus tract with methylene blue using a Leur syringe with a gooseneck canula (used in intravenous work, specially ground to fit a Leur syringe) and using pressure, the mouth of the sinus tract being compressed about the canula with a forcep to prevent leakage The blunt end of the canula rather than the sharp pointed needle will insure injection into the sinus tract rather than the perisinus tissue, and clamping the mouth of the sinus around the canula and using pressure in injecting the methylene blue will result in a more successful injection of communicating tracts and penetrate more deeply A wide dissection of the tract within the soft parts down to the sacrum and coccyx is accomplished and then the coccyx is excised at the sacro-coccygeal joint Finally the articular surface of the sacrum and sacral hiatus are curetted In closing the wound, Lahey's<sup>8</sup> last modification has been employed—making an incision to the side down to the bone, undermining the intervening tissue at its attachment to the bone, making of it a double pedicled flap and moving it over to the midline and fixing it there with a couple of sutures to the sacrum The two skin incisions are then closed with interrupted sutures excepting on one side at the most dependent point which is allowed to remain open and a rubber tube drain inserted The drain may be removed in three or four days and the wound will close in about three weeks There has been no occasion to open any of the wounds to secure better drainage and by practicing primary closure the patients have been saved many days in the hospital The wounds have all healed favorably and no symptoms have been complained of either as a result of the loss of the coccyx or any unpleasant sensations from the scars

*Conclusion*—A certain percentage of pilonidal cysts, sinuses, dimples and sacro-coccygeal dermoids will be cured by bloc dissection of the soft parts over the dorsum of the sacrum and coccyx, but in those cases that have recurred after a careful bloc dissection of the soft parts, those in which an X-ray examination of a sinus tract injected with lipiodol or other substance opaque to X-rays shows the tract to invade the sacro-coccygeal joint, those in which after a careful injection with methylene blue show a discoloration at the sacro-coccygeal joint and in those where the character of the tissue about the sacro-coccygeal joint is under suspicion it is argued that a remnant of the cyst wall or sinus tract is contained within the sacro-coccygeal joint as an unobliterated portion of the medullary canal and a cure will be accomplished by excision of the coccyx which will remove this remnant of the cyst wall or sinus tract

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## THE HEALING OF SURFACE WOUNDS FOR THE PREVENTION OF DEFORMITIES \*

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THE problem of wound healing, in cases in which a large amount of integument has been removed from the body surface, is second in importance only to that of saving the individual's life. This statement may appear to be elemental, but it is a fact that the surgeon only too often, following his successful efforts to save life, loses interest in his patient and neglects to give the proper help to hasten the covering of the raw surface of the wound with new skin. The result is that the healing period is prolonged and an excess of cicatricial tissue is formed which is followed by contractures producing deformities, failure of epithelization or the formation of skin of such poor quality from lack of circulation that the scar breaks down and ulcerates following the least bruise. The following case history well illustrates these sequelæ.

A boy, ten years old, suffered a third-degree burn of his left leg which extended from just above the ankle to above the knee. He was treated at a hospital by soda-bicarbonate dressings. The extremity was not immobilized and skin grafting was not done. He remained in the hospital for ten months, during which time the wound slowly became covered with skin, through the advancement of the epithelium from its edges. During this time the knee-joint became flexed from contraction of the scar tissue in the popliteal space. The mother finally removed the boy from the hospital, as amputation was advised.

When seen by one of us, ten months following the accident, the child was in a pitiable condition. The left knee was held by a contracture of the scar tissue at a flexion of 90°. On the anterior mesial aspect of the leg there was an ulcer four by two inches, with a base of atrophic granulation tissue and the surrounding new formed skin was thin, shiny and scaling.

Before the contracture at the knee could be corrected, the ulcer had to be excised and grafted. Following the correction of the deformity, when the boy was allowed up and around, the undernourished skin upon the leg broke down and ulcerated and this had to be excised and grafted. He remained hospitalized altogether eighteen months and underwent operations on four different occasions for the excision of scar tissue and skin grafting.

Hypertrophied scars and keloids are not uncommon sequelæ to wound healing, when a large area of skin has been removed. The pathological scar tissue may become of cartilaginous density, building up an irregular tumor mass covered with thin epidermis which frequently breaks down and ulcerates. This produces an unsightly deformity and is a potential danger, in as much as malignant changes of the epithelium are not a rare occurrence in old scars. Johnson<sup>5</sup> emphasizes the danger of this occurrence and advises the early skin

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grafting of wounds in the prevention of the formation of cicatrices which may undergo carcinomatous changes

A boy fifteen years old sustained a burn of his right forearm and hand, and left popliteal region one year before his admission to Bellevue Hospital. The burnt region had been treated by a popular patent ointment, the parts were not immobilized nor were the wounds skin grafted. The wounds were not completely healed for six months. Overgrowth of scar tissue was noticed at the end of six months and soon after the left ring and little fingers commenced to become contracted and the hand to deviate to the ulnar side. The scar in the popliteal space hypertrophied and became nodular. On being allowed up on his feet, this scar commenced to ulcerate.

When admitted to the hospital, both scars were much hypertrophied, the tissue having the consistency of cartilage. They were well circumscribed, the normal surrounding skin being directly attached to the edges of the scars. The surface of the cicatrix was nodular and the skin covering the scar tissue was smooth, glistening and firmly attached to the underlying fibrous tissue. The tumor on the mesial border of the wrist, extending from the lower third of the forearm to the metacarpophalangeal joint, was spindle-shaped, measuring six inches in length, two inches at its widest point and one inch thick. The scar in the popliteal space was irregular in shape, eight inches long and four inches wide. Its nodular surface was ulcerated.

The tumor of the wrist, following removal, cut with cartilaginous hardness. The sectioned surfaces were smooth, pale and glistening. Microscopical examination showed the tumor to be composed of a very dense fibrous tissue.

Examples of deformities similar to these are not uncommon, and the history, obtained from the patient, often informs us that the individual's injury had been treated in a well-organized hospital, where the primary traumatic condition had been cared for but no attempt had been made to cover the wound surface with skin. It is for this reason that we wish to present our experience of treating large surface wounds by early skin grafting.

The depth of the wound varies in the case of a burn. To have an open surface following the separation of the eschar, the entire thickness of the epithelial cells must have been destroyed. In the more superficial types, the epithelial cells of the deeper portions of the hair follicles, of the ducts of the sebaceous glands and of the sweat glands may remain viable and act as islands, from which the cells spread out to cover the intervening raw surface. In this type of case, healing occurs with little contraction of the wound. The deeper types of burns usually involve the fat or areolar subcutaneous tissue. When the eschar separates from these wounds, which occurs between the third and fourth weeks if infection has been absent, the surface is composed of healthy granulations.

In the case of an avulsion of the skin, the subcutaneous tissue is torn off, leaving deep fascia, muscles, bone, vessels and nerves exposed. The fresh wound from this type of accident occasionally has the appearance of a careful dissection. The wound is often primarily infected and much of the surrounding skin and soft tissues are so damaged that they may later slough. In the healing process, the granulations form rapidly upon the surfaces of the muscles. The aponeurosis, tendons, ligaments, cartilage and bone remain exposed for a longer time, and, if infection has been present, the separation

of the slough upon their surfaces has to occur before the granulation tissue can form, and, consequently, healing may be slow

A severe contusion to one of the extremities will at times produce a slough of a comparatively large area of the overlying skin. The separation of the slough occurs in a similar manner to that of the eschar of a burn, but it is a much slower process. If the sloughing tissue is kept dry (we treat this type of wound in a hot-air tent), secondary infection is prevented and a healthy granulating surface is exposed when the slough separates.

Gangrene of the skin, the result of an infection, which is usually a symbiosis of bacteria, may be followed by a large surface wound. Here the aponeurosis and tendons are exposed and may slough, prolonging the time of appearance of granulation tissue.

An open wound is healed by a combination of the production of granulation tissue, which springs from the denuded surface and fills in the space between the wound edges, and by the creeping in of epithelium from the edges to cover the raw surface. Accompanying this, there is a contraction of the wound surface which may amount to as much as one-third of its area. When the scar of such a wound is situated upon a portion of the body where the subcutaneous tissue is loose and the skin is freely movable, the resulting deformity and loss of function is not great—as an example, the abdominal wall, where a comparatively large wound causes little disability. When, however, the wound is upon the neck or on an extremity, especially if it be upon the flexor surface of a joint, the resulting cicatrix causes both disfigurement and disability. The contraction of the wound surface is at first rapid but later slows down. Carrel and Hartman<sup>1</sup> and also DuNouy<sup>3</sup> have studied the rate of cicatrization of wounds. The former writers arrived at the conclusion that the rate of cicatrization is greater at the beginning than at the end of the period of repair, that there is a constant relation between the size of the wound and the rate of cicatrization, that the larger the wound the greater is the rate of cicatrization, that the process of contraction is the more important factor in the repair of a wound, that epidermization completes the work of contraction and after the wound is healed the cicatrix as a rule expands. DuNouy has expressed the rate of cicatrization, which is a constant for wounds of the same size, by a mathematical formula

The contraction of the wound is the result of shrinkage of the new fibrous tissue which has developed from the granulation tissue, and, consequently, the larger the surface area of the defect, the greater will be the amount of contraction. The amount of new fibrous tissue depends upon the extent of the growth of the preceding granulation tissue. Little scar tissue develops in small wounds where healing is rapid, while much is formed in large wounds because of the delay of epidermization with the consequent overgrowth of the granulation tissue. When healing is delayed, as in the centre of a large wound, the covering layer of granulation tissue thickens, thereby causing an excess of scar tissue. The increase of granulation tissue, however, eventually stops, for its production upon the surface becomes limited, owing to the lack of vascularity as exemplified by the pale, shiny,

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atrophic granulations of old ulcerations The vascularity of this tissue is poor and further growth on the surface is impeded because the circulation has become depleted, the arteries having been constricted by the contraction of the old fibrous tissue at the base through which the vessels pass to the periphery

If a vertical section through fairly old granulation tissue (Fig 1) is examined under the microscope, we find the structure of the superficial layer quite similar to young granulation tissue It is vascular, there are many capillaries with their long axes perpendicular to the surface and the intermediate tissue is composed of young connective-tissue cells with rounded nuclei lying in a loose stroma The appearance of the deepest



FIG 1—Section of old granulation tissue, the superficial portion contains vascular granulations with capillary loops, the deepest layer is composed of dense avascular fibrous tissue with bundles of fibres parallel to the surface

stratum is quite different, it is composed of bundles of dense connective-tissues fibres which run in a direction parallel to the surface There are few cells and their nuclei are elongated, flattened and lie in the same direction as the fibres The vascularity is poor and the few vessels which are present run parallel to the bundles of fibres Between the superficial and deep layers is an intermediate zone in which the tissue shows a gradual transition in its morphology as we pass from the young superficial layer to the older deep one

The first sign of epithelial growth becomes evident when the level of the surface of the granulations has reached that of the skin The advance of the skin edges is at first rapid but gradually lessens in speed The centre of a large wound may fail to become covered with epithelium or the covering skin may be of such poor quality that it scales, forms blebs and repeatedly breaks down and ulcerates Hartwell<sup>4</sup> states that "the formation of the



healing epithelial membrane is dependent on a supporting base suitable for the movement of epithelial cells. The base available for the support and advance of the epithelial membrane is the chief factor determining the time and place of the union of the epithelium from the two sides of the wound. The rate of the cornification of cells of the membrane is also a determining factor in the rate of the process of covering with epithelium. The chief causes of delayed epithelial healing, therefore, are the existence of a supporting wound surface unsuitable for progression of epithelial cells, and rapid cornification of the cells of the membrane due to inimical chemical



FIG 2.—Section through the surface of a recently healed flat scar. The epidermis lies directly upon scar tissue, in which there are few vessels. The papillæ of the skin are absent, as well as hair follicles, sebaceous glands, and sweat glands. The number of layers of cells of the epidermis is decreased and its surface is covered with a loosely attached keratinized layer. There is a fissure in the skin surface which has become infected.

or physical environment. The conditions just named are accentuated in infected wounds."

The skin which forms upon old granulation tissue is of poor quality, due to the too rapid cornification of its epithelium. This skin does not withstand the normal requirements of the body. It is thin, dry and brittle. Its surface is bluish in color, shiny and scales easily. It readily cracks, and blebs form beneath the cornified layer, which break down, leaving a pale, weeping surface. Slight bruises produce abrasions which ulcerate. These complications commonly occur in scars upon the lower extremities. The lesions heal when the patient is put to bed with the limb elevated, but recur when he is allowed up.

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If a microscopical section is made vertically through the surface of a scar which has healed by granulations and the spreading in of the epidermis from the wound edges (Fig 2), we find that the new epithelial layer lies directly upon the fibrous tissue produced from the granulating surface. There is no corium, the epidermis grows directly upon the scar tissue and there is an absence of the papillæ. Elastic fibres are absent and the scar tissue contains few blood-vessels. The epidermis is thin, apparently having less layers of cells than normally, for many of the cornified layers of cells are absent and the periphery is covered with a thin keratinized layer, which is loosely attached.

Avascular granulation tissue forms an unsuitable base for the healthy growth of epithelium. Epithelization fails to occur or a rapid cornification supervenes and the skin breaks down. A vicious circle ensues, the delay in epithelization increases the amount of scar tissue, diminishing the vascularity of the surface granulations which form a base to the epithelium, and this, in turn, further retards the growth of the epithelium.

The secret of the prevention of deformities and disabilities in the healing of superficial wounds is by supplying to them an early covering of integument so that their surfaces will be covered before an excess of fibrous tissue is produced. The supplying of islands of new skin evenly distributed over the denuded surface, during the early stage of the process of healing, will hasten the epidermization of the wound, preventing an excessive production of scar tissue and thereby eliminating much of the contraction of the wound. In other words, in wounds treated in this manner the contraction of the wound, which Carrel and Hartman believe to be the important factor in cicatrization, is lessened and the epidermization which, they state, "completes the work of contraction" becomes a more active agent. Splinting, traction and other mechanical means to prevent contractures are useless. They are merely methods directed to correct the obvious result of the underlying condition. They do not attack the root of the evil, which is the excessive formation of granulation tissue, the precursor of scar tissue. These agents are useful adjuvants to the treatment of wounds, in obtaining immobilization and thereby promoting wound healing, but here their usefulness ends.

The ideal treatment from every standpoint is an immediate plastic repair of the wound\*. But, unfortunately, this is seldom possible, as devitalized tissue or infection is present in most wounds which are the result of burns or trauma, and we must, consequently, await the time when the sloughs have separated or the acute infection is under control before a plastic repair can be considered. It will then be possible to cover the raw surface of the wound with skin grafts, with sufficient prospect that they will grow.

In burns which are treated by means of tannic acid, the eschar separates from the wound surface at the end of the third or fourth week, leaving a healthy, firm, smooth, granulating surface, ideal for the growth of grafts. In infected wounds, especially those following the avulsion of the skin and

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\* The immediate application of a pedicle flap in lacerated wounds of the hand is an ideal procedure and should be used whenever possible in the treatment of these conditions, as the subcutaneous tissue of the flap prevents the scar from adhering to bones and tendons, as well as preventing the formation of scar tissue.

subcutaneous tissues, the sloughs from the tendon and aponeurosis are slow in separating, though the granulation tissue covering the muscles is ready much earlier. The time for grafting should be immediately following the separation of all eschar or slough. Grafts will not grow in the presence of sloughing tissue, in the proximity to open sinuses or on surfaces contiguous to active inflammatory processes. The purulent discharge from otherwise healthy granulations does not appear to be detrimental to their growth. The most satisfactory surface upon which to graft the skin is a freshly prepared one, from which the overlying integument has been recently removed, or one covered with a thin stratum of healthy granulation tissue having a smooth surface. Hartwell has shown that the migration of the epithelial cells of the skin is more rapid upon a smooth surface than on one which is irregular and rough. The surface left by the recent separation of a tannic-acid eschar fulfills these requirements.

No particular preparation of the surface which is to be grafted is necessary if the granulations are young, firm and clean. The surrounding skin should be cleaned for several days prior to the operation, to prevent a later secondary infection. A wet dressing of normal saline or boric-acid solution should be used for twenty-four hours preceding the grafting, to remove the crusts formed by the exudate from the raw surface. If the granulations have become exuberant and soft, the projecting surfaces should be cut down and strapped with adhesive plaster for several days prior to operation. Old, avascular granulation tissue should be excised down to the normal tissue upon which it lies. This can be done a day or two previous to the skin grafting or immediately before, the grafts are then laid upon the exposed deeper tissue. Curetting the surface of the wound is useless, as this only removes the superficial layer of soft tissue, leaving behind the deep fibrous layer through which the vessels pass. The vascularity of the surface of the wound, consequently, is not improved. Wounds that are actively inflamed should be treated to rid them of the infection.

Given a satisfactory surface for grafting, the additional qualification required in the wound is that it be situated in such a position upon the body surface that firm pressure and complete immobilization can be obtained. An underlying bony surface, such as the skull, covered with vascular granulations, is an ideal situation. Proper immobilization of the part is necessary to prevent the shifting of the grafts. Successful grafting of the surface of the neck is difficult, for here neither firm pressure nor complete immobilization can be obtained.

The type of skin grafting to be used is purely one of personal choice. Some type of free graft is preferable, as pedicle flaps are unsatisfactory when employed upon a granulating surface because of the danger of infection. Large, full-thickness grafts (Wolff) are not to be used for the same reason. The autogenous or autografts should be used, as homologous or isografts are extremely uncertain in their ability to grow upon the new host. In our experience, we have found the "full-thickness pinch grafts," also referred to

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as "small deep grafts," to be the most satisfactory. These, when placed at sufficient intervals upon the surface, give islands of full thickness of skin from which the epithelium grows out (Fig 3), forming a layer of skin which joins other growing cells from nearby grafts. This skin which forms between the individual grafts is healthy in character and does not undergo a too-rapid cornification, for it has sufficient vascularity, if the grafts have been placed close enough together, because the intervening granulations of the base are covered with epithelium before they have had time to form an excess of fibrous tissue. We also feel that the islands of full thickness of

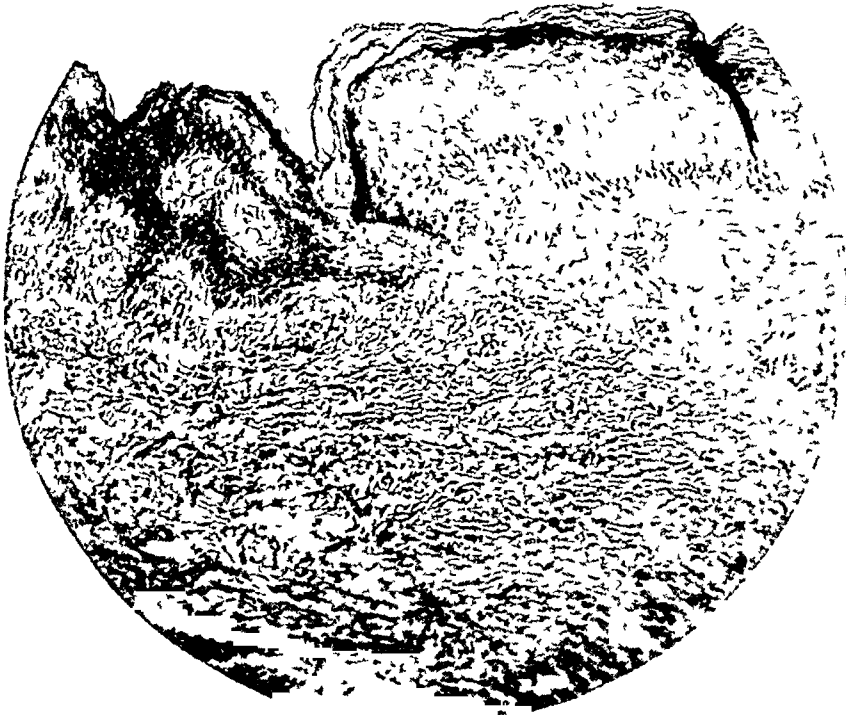


FIG 3.—Section through the surface of scar that has been grafted. On the left there is the edge of a full thickness pinch graft, which has the morphology of normal skin. On the right is epidermis that has grown from the edges of the graft. This is well vascularized and is thick and firm, though it rests upon new formed fibrous tissue and is covered with a keratinized layer of cells.

skin give an elasticity to the new-formed integument, which is not obtained when the Ollier-Thiersch or true Reverdin grafts are used. We have had fewer failures in grafting when using the small full-thickness grafts than when we used any one of the other types. The ease in which the grafts can be cut when using a local anæsthetic is of advantage to the patient. The disadvantage of the use of the "pinch graft" is merely the poor cosmetic result that is obtained, as the spotty-like character of the scar is not attractive.

The technic of skin grafting is simple, there is nothing complicated about it and anyone with the smallest amount of surgical training should be able to carry it out successfully. But why, you may ask, are there so many

failures? We believe the failures are due to two main causes. First, in not operating early enough, when the amount of granulation tissue is small and the surface is vascular, and second, in not paying the strictest attention to the details of the dressing, which is applied following the operation. Many surgeons are apt to leave the dressing of the case to their juniors, not realizing the important relation this part of the procedure bears to the success of the operation.

*The Technic of Skin Grafting ("Pinch Grafts")*—A general anæsthesia is used with young children. A local infiltration of a solution of 1 per cent procaine, to block off the area from which the grafts are to be obtained, can be used with some older children and adults. In choosing the area from which the grafts are to be obtained, it is well to select one which has skin similar in texture, color and quantity of hair to that to which the grafts are to be transferred. This is not so important in the case of grafting upon the extremities as it is upon the face or neck, where the cosmetic result is of such consequence. The skin surface from which the grafts are to be taken is prepared by washing it with soap and water and flushing with alcohol and ether. If a wet dressing of saline or boric-acid solution has been used previous to operation, the granulating surface will need no further preparation. To disturb this surface by preparation at the time of operation may produce bleeding from the granulations, which is detrimental to the growth of the grafts. The skin surrounding the wound is merely cleaned and wiped off with alcohol and ether. The grafts are obtained by lifting up a cone-like projection of skin on the point of a straight needle and cutting it off with a razor blade or sharp knife, the flat surface of the blade being held in the same plane as that of the skin. The size and depth of the grafts are controlled by the amount of skin that is lifted up with the point of the needle and by the depth at which the knife cuts. The size of the graft should be approximately three-eighths of an inch in diameter. After removal, this shrinks to two-thirds of this size. The raw surface of the grafts should have no fat upon it. A graft cut in this manner has at the centre of its circumference the full thickness of the skin, which tapers off in thickness toward its edges. These are spoken of as "small deep grafts," or "full-thickness pinch grafts." The grafts are laid, with their raw surfaces upon the granulation tissue, without attempting to uncurl them. They are placed so that their edges are not more than a quarter of an inch apart, at least four pinch grafts to each square inch of surface area. The closer they are placed to each other, the more rapidly will the surface be covered with skin. The grafts must be placed closer together over the flexor surfaces of joints, such as in the popliteal and cubital fossas, than over the less movable parts of the body. When the area of the wound is large and cannot be completely grafted at one sitting, it is better to cover a small part of the surface with a sufficient number of grafts than to scatter the same number over the whole surface, and the area chosen should be that over the joint surface, preferably the flexor surface. The technic of cutting and placing the grafts is extremely simple. Several needles are used: the operator cuts the grafts and his assistant places them upon the surface of the wound, using a second needle to remove the graft from the point of the first. On parts of the body where it is impossible to use sufficient pressure to keep the grafts in firm contact with the surface of the wound, or where complete immobilization cannot be attained, we have buried or implanted<sup>a</sup> small pinch grafts into the granulation tissue.

The dressing of the grafted area, as we have said, is of the greatest importance. This must protect the wound from infection, produce sufficient pressure upon the grafts to hold them in firm contact with the surface upon which they lie and prevent them from shifting upon their new bed. The

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technic may vary in the hands of different surgeons, but the principles of all are the same

The dressing which we use is simple and efficient. The grafted surface is covered with strips of paraffin gauze to hold the individual grafts in their relative positions upon

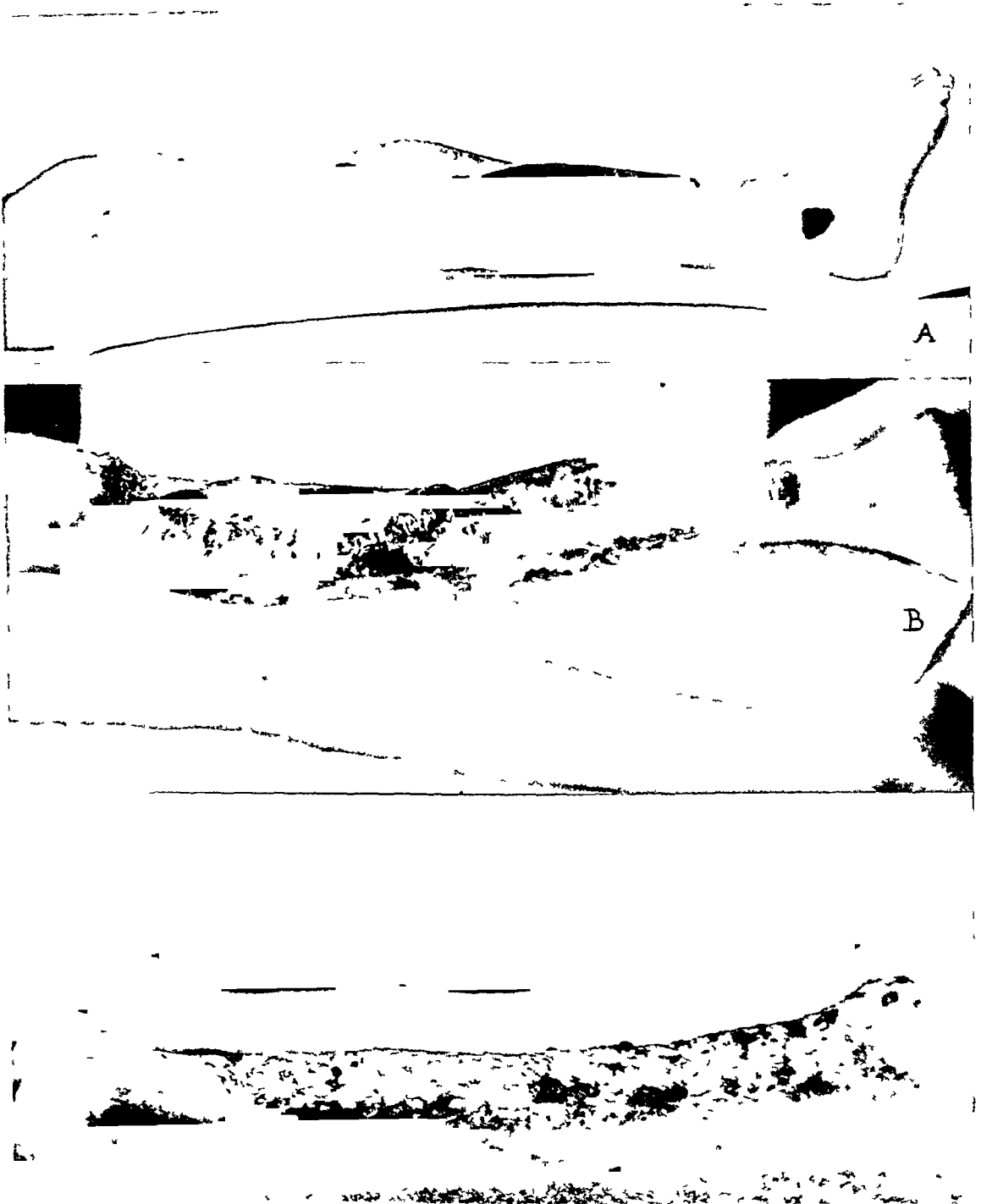


FIG 4 —(Case IX) Third degree burn of back of leg. A—Tanned area of burn. B—Tannic acid eschar separating from wound. C—Wound three weeks following skin grafting.

the wound surface while the outer dressing is being applied. The paraffin gauze is cut into strips one and a half inches wide and sufficiently long to cover the width of the wound and extend for a few inches beyond its edges. This is softened, just before using, by immersion in a warm solution of saline. The strips are placed so that the edge of one overlaps the other. The paraffin gauze is covered with four or five thick-

nesses of a flat gauze dressing which is snugly bandaged in place with a gauze roll. The part is then covered with an excessive amount of coarse non-absorbent cotton or "quilt wadding" about four layers in thickness. (Non-absorbent cotton retains its elasticity, as its vegetable oils have not been removed. Any type of refined cotton is useless.) The cotton is firmly bandaged and this is reenforced by spiral turns of strips of adhesive plaster. Firm pressure is obtained in this manner. The part is then encased in light plaster, which should immobilize the joints proximal and distal to the grafted area.



FIG 5 —(Case XVI) Stocking like avulsion of skin and subcutaneous tissue of leg A—Before skin grafting B—After grafting mesial surface of leg

The dressing is not disturbed for eight days, when the plaster casing is removed and the wound is dressed. The grafts, if they have taken, are found firmly attached and their new blood supply is established (Davis<sup>2</sup>). The wound may now be covered with vaseline strips, over which is placed dry gauze. Two weeks after operation, the wound is strapped in a fenestrated manner with strips of adhesive plaster. This keeps the granulations flat, providing a favorable surface for the migration of the epithelial cells in their growth from the edges of the grafts. The individual should not be allowed out of bed until the wound has been completely healed for ten days or two weeks.

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The cases from which this study has been made were of patients treated by us and other members of the staff of the Children's Surgical Service at Bellevue Hospital, during the past six years. There were twenty-five cases in all, fourteen with wounds which were the result of third-degree burns and eleven of avulsions of the skin or crushing injuries.

The surface area of the smallest wound was approximately twelve square inches in extent and the largest was a stocking-like avulsion of the entire skin and subcutaneous tissue of the lower extremity which extended from the mid-thigh to below the ankle (Case XVI, Fig. 5). In most cases deformities and disabilities, the result of contractures, were inevitable unless skin was supplied to fill in the loss.

The loss of skin in most of these cases involved one or more of the joint surfaces, frequently the popliteal fossa and often the cubital fossa. Case I was a burn of the lower extremity which completely removed the skin from the inguinal region to just above the ankle. Another case (Case XVIII) was one in which the skin and subcutaneous tissue was avulsed from the posterior surface of the thigh to the middle of the calf, exposing muscles and vessels of the popliteal space.

In classifying the results, we have considered the extent of the injury in relation to the amount of soft-tissue contracture that followed. Where there was no evident contracture the result has been considered as good, a slight contracture

fair, and a marked loss of function poor. Several of the patients had accompanying injuries of bones and joints, the disabilities resulting from these additional injuries have not been considered in reaching a conclusion. This classification is far from satisfactory, is open to criticism, and must therefore be considered merely empirical, for there are so many facts to be considered in each case that a more accurate type of classification is impossible. There were eighteen cases with good results, nine of burns and nine of wounds from avulsion of skin, four with fair results, three burns and one avulsion, and three with poor results, two burns and one avulsion. Our worst results, however, are far better than if the wounds had been left ungrafted.



FIG. 6 — (Case XVI) End result, seven years following accident



One of these (Case X) was a little girl with an extensive third-degree burn of the face, neck, chest and both axillae. The wounds were completely healed five and a half months following her admission to the hospital. The contracture of her neck and lip, though marked, is much less than if her wounds had not been grafted, for the chest and axillae are covered with a soft skin and a plastic repair in the future will be far easier than if she had been left untreated. Another poor result (Case V), was a patient who had a burn of the skin of the cubital fossa. This wound was not grafted until the fifty-fourth day following the accident. On healing, a contracture formed which slightly limited the extension of the elbow-joint. This was evidently due to the tardiness in grafting. The third case (Case XVII) was that of a boy who had an avulsion of skin from the back of the forearm and wrist, which resulted in a limitation of the flexion of the wrist, apparently due to the inclusion of the extensor tendons, which were exposed by the avulsion, in the cicatrix. Again a failure to heal the wound in the early stages



FIG. 7—(Case XVI). Seven years following accident. Illustration to show character of new skin.

There was scar tissue in all the wounds. This is inevitable in wounds healing through granulations. Those whose surfaces were most rapidly covered with skin showed the least amount of scar tissue. Much of this which was present in recently healed wounds, was later absorbed, the cicatrix becoming softer and more pliable. In recently healed wounds the new-formed skin, that is the portion between the grafts, was thick and had a tendency to undergo a too-rapid cornification. This portion of the integument was leathery, red and scaly, but the grafts retained the appearance and texture of the skin from which they had been obtained. Later the integument between the grafts became softer and pliable, losing its congested appearance and the tendency to rapid cornification. In many of the cases of several years' standing, the surfaces of the scars have become uniformly smooth and soft and the grafts can scarcely be distinguished from the epidermis which lies between them.

## HEALING OF SURFACE WOUNDS

The grafting of wounds situated upon the extremities was more successful than that on other parts of the body, as firm pressure upon the grafts and complete immobilization of the limbs was easily attained. The grafting of wounds upon the neck and ventral surface of the trunk was not so successful, because of the inability to prevent shifting of the grafts. In several instances, we buried or implanted small pinch grafts into the granulating surface of wounds upon the neck, hoping in this way to obviate the necessity of holding the grafts in position. These attempts, however, were not successful.

We are under the impression that the placing of grafts upon a granulating surface stimulates the epithelial growth of the wound edges. We have often observed this but cannot explain its action.

### SUMMARY

(1) Deformities may result from the unaided healing of large wounds on the surface of the body.

(2) The cicatrization of a wound is due to the contraction of its area and to the epidermization of its surface.

(3) The contraction of its area is due to the fibrous connective tissue which develops from granulation tissue.

(4) An excess of granulation tissue is followed by a maximum amount of scar tissue, which results in contraction of the cicatrix and poor skin formation.

(5) Early skin grafting hastens healing of the wound by decreasing the amount of contraction and increasing the epidermization. The fibrous tissue is less and the skin which is formed is of better quality than if the wound is allowed to heal without help.

(6) Skin grafting should be done early in the course of healing, while there is but little granulation tissue present.

(7) The success of skin grafting depends upon the condition of the wound surface and the attention paid to the details of the operation and dressings.

(8) The results of twenty-five cases of severe surface wounds treated by early skin grafting are reported.

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# THE USE OF LEECHES IN THE TREATMENT OF PHLEBITIS AND THE PREVENTION OF PULMONARY EMBOLISM

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NOTHING is probably so tragic as sudden death from pulmonary embolism occurring in a patient who is recovering from an operative procedure. Fortunately, not all pulmonary emboli produce a fatal termination, in fact, the majority produce relatively mild symptoms and may not even be recognized. Moreover, the involved vessel with its contained thrombus whence the embolus originates frequently cannot be demonstrated clinically.

It is difficult to accurately determine the incidence of phlebitis after operation. Albanus reported that femoral thrombophlebitis occurred sixty-three times after 1,140 laparotomies. Forty-four of these cases resulted in embolism of which ten of the patients died. Femoral thrombophlebitis, therefore, occurred in 5.5 per cent of the cases in his series of laparotomies. The incidence of fatal embolism in the whole series was 87 per cent and 15.9 per cent of the cases that developed femoral thrombophlebitis resulted in fatal embolism. These percentages are higher than those given by other authors. Schneck reported forty-eight cases of thrombophlebitis occurring post-operatively in 7,130 cases (67 per cent). Cordier stated that thrombophlebitis occurs in 2 per cent of all laparotomies. Of 30,803 operated cases, Sulger and Boszin report that there were 1,630 deaths, of which 1,304 were autopsied. Ninety-nine of the fatalities were the result of embolism. This represents 32 per cent of the operated cases and 6.1 per cent of the deaths. Henderson reported that 6 per cent of the deaths following operation at The Mayo Clinic in a ten-year period from 1917 through 1926 were caused by pulmonary embolism. In this series, there were 63,345 intra-abdominal operations with 180 fatalities from pulmonary embolism, in addition to extra-abdominal operations in which fatal pulmonary embolism occurred in forty-three instances. Fatal pulmonary embolism occurred after 3 per cent of the operations on the gall-bladder and bile ducts, after 25 per cent of the stomach operations, after 38 per cent of the operations on uterus and appendages, after 46 per cent of the operations on the prostate. Henderson's figures are comparable to those reported by Sulger and Boszin.

From the figures quoted above, it is readily seen that post-operative thrombophlebitis with its resultant pulmonary embolism is one of the "Captains of the Men of Death" to the surgical patient and measures which will appreciably reduce the 6 per cent of surgical deaths attributable to pulmonary embolism in addition to embolic pneumonia and other sequelæ of post-operative thrombophlebitis certainly are to be welcomed.

In the past, various measures have been suggested to curtail this mortality having the patient's extremities gently massaged to prevent stagnation of the

# LEECHES IN TREATMENT OF PHLEBITIS

blood, encouraging the patient to move about in bed, and to take deep breathing exercises so as to increase the negative pressure in the thorax and thus increase the flow of blood from the inferior vena cava (Henderson, Walters, Ries, Richardson, Boldt, and Pool) Walters has reported a diminished incidence of fatal pulmonary embolism (09 per cent of operated cases) following the routine administration of desiccated thyroid in conjunction with physical attempts to speed up the circulation such as movement of the limbs and deep breathing Astanasof, on the other hand, reports that among 170 patients receiving thyroid extract post-operatively, fatal pulmonary embolism occurred twice, non-fatal embolism once, pulmonary infarction five times, and thrombosis, ten times

Termier deserves credit for reviving the leech treatment in cases of phlebitis He reported in 1922 nineteen cases of phlebitis in which there was early abatement of symptoms after leech treatment This form of therapy has been used extensively in Europe, and there are in the literature clinical reports of the use of leeches in phlebitis by many authors (Table I) Because of these apparently brilliant results, we were encouraged to use leeches in the treatment of thrombophlebitis

TABLE I  
Cases of Phlebitis Treated

Author	Year	Post-operative	Puerperal or Pregnancy	Not Surgical or Puerperal	Fatal Pulmonary Embolism	Remarks
Termier	1922	19			0	
Termier	1925		73		0	
Julliard	1925	3			0	
Gonnet, <i>et al</i>	1926		6		0	
Beguer	1927		1		0	
Tholen	1927	11	38			Author saw seven additional cases in consultation and used leeches
Hamm, and Schwartz	1927		23		0	Not stated whether surgical or puerperal Two cases had pulmonary embolism apparently not fatal
di Pace	1928		5	5	0	
ten Berge	1928	1			1	Only two leeches were applied
Vidal	1928		1		0	
Chavannaz, and Magnan	1928					
			10		2	Number of leeches used not stated
Ducuing	1928		50		0	
Sulger, and Boszin	1929	10			0	3,316 surgical cases treated prophylactically with leeches
Muresanu	1929	8			0	
Rossi	1931	11			0	

*Technic of the Application of Leeches*—Usually it is not difficult to get the fresh leech\* to bite. Shaving the skin and cleaning with ether and alcohol have been recommended, but we have applied leeches without any special preparation and have not encountered any untoward results. One of the best methods of applying a leech is as follows:

A leech is picked up with long forceps or the fingers and is placed caudad end first in a test tube. About 2 cubic centimetres of 10 per cent sugar in water are placed in the test tube and the tube is inverted with its mouth over the involved area. The leech follows the sugar water down the tube and may bite under the solution but at times it is advantageous to let the solution escape from under the rim of the tube. When the leech has attached itself by the oral sucker to the skin, which is apparent both to the physician and to the patient, the latter feeling the grasp and perhaps a little pain the test tube may be removed. Sometimes the leech holds on tenaciously with the caudad sucker, and it is necessary to dislodge this from the tube by introducing an applicator into the test tube and undermining this sucker. The leech then stretches out on the skin of the patient and holding with both suckers will continue to suck until it becomes so heavy and distended with blood that it falls off. This generally requires from thirty to sixty minutes.

In applying leeches for phlebitis, the site of election is in the region of the thrombosis. It is as yet disputed whether the good effects are due to the action of hirudin locally or through the general circulation (v 1), but the application of the leeches in the region of the thrombus is more likely in one and as likely in the other instance to secure the desired effects. From six to eight leeches should be applied at one time. This number may be repeated after twenty-four to forty-eight hours if the thrombophlebitic process does not subside. Eighteen or more leeches may be used.

We have used leeches in four cases of thrombophlebitis. The patients were all males. None of them had been operated upon. In two patients the phlebitis occurred in the left femoral vein. One patient had three attacks of phlebitis in different areas of varicose veins and one patient with thrombo-angitis obliterans had a sudden thrombosis of the popliteal vein.

CASE I.—P. D., male, aged forty-three years, a carpenter, was admitted to the Charity Hospital October 6, 1931. His trouble started in January, 1931, with burning pain in the right foot. This persisted and by June, 1931, he had intermittent claudication. Just before admission, he developed a punched-out ulcer on the dorsum of the right foot. He suffered severe pain in his foot, constant rest pain which was less severe when the foot was dependent.

The right foot was of a purplish-red color and the small ulcer, one by one centimetre, was present on the dorsum. On elevation, the foot blanched rapidly and there was a tardy return of color. The dorsalis pedis and the posterior tibial pulses on the right were not perceptible. There was slight œdema of the foot. The diagnosis was thrombo-angitis obliterans. There was no evidence of disease elsewhere in the body.

During a course of typhoid vaccine on October 26, the patient developed a migrating phlebitis on the inner aspect of the right calf. October 29, marked œdema of the right leg below the knee was observed and a tender, thick, rope-like mass was felt in the right popliteal space. This was obviously a thrombosed popliteal vein. October 29 five leeches were applied to the inner side of the right leg. These had no effect on the

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\* One which has not been used for several months.

## LEECHES IN TREATMENT OF PHLEBITIS

phlebitis or course of the disease This was the first case in which we used leeches The treatment was obviously inadequate It was eventually necessary with the advancement of gangrene to amputate the leg The details of this case of thrombo-angitis obliterans have been reported by one of us (H R M)

*Summary of Case I*—A man, aged forty-three years, with thrombo-angitis obliterans, developed a sudden thrombosis of the popliteal vein Five leeches were applied to the extremity This was the first case in which we applied leeches for thrombosis The treatment was inadequate, the result nil, but this raises the question and possibilities of leech treatment and humidization in thrombo-angitis obliterans

CASE II—L T, male, aged sixteen years, a farmer, was admitted to the Charity Hospital December 7, 1931 He complained of pain and swelling of the left leg Present illness began eighteen days before admission He first noticed pain in the left inguinal region The following day the left thigh was swollen he had mild fever, and the pain was so severe he was forced to remain in bed

Three days following the onset his tonsils were removed under general anæsthesia The swelling and pain in the leg persisted

*Examination*—The entire left leg was moderately œdematous The left femoral vein in Scarpa's triangle was palpable and of rope-like hardness It was tender, the tenderness being marked over the upper part of the left long saphenous vein The dorsalis pedis and the posterior tibial pulses were palpable His temperature was  $101.3^{\circ}$  and pulse 116

Four leeches were applied to the inner side of the left thigh On the following day, December 8, the pain had entirely disappeared and the œdema had subsided appreciably

The circumferences of the legs were measured at different levels

	Left	Right
Mid-thigh	46.25 centimetres	38.75 centimetres
Calf	31.8 centimetres	27.5 centimetres

The bleeding time was one minute

December 9, five more leeches were applied to the left thigh The vein was still palpable, but the œdema had subsided even more His temperature rose to  $101.2^{\circ}$

December 10, the leg was still swollen, but the patient had no pain Three more leeches were applied to the left thigh December 12, the patient was vaccinated, because a case of smallpox had been discovered in the hospital The vaccination was successful, the wound became infected, and the patient continued to have some fever, gradually subsiding to the time he was dismissed We were of the opinion that the fever during the latter part of his stay in the hospital was due to the vaccination

The patient had no further pain from the thrombosis and the œdema had decreased, but on December 19, the left femoral vein was still palpable On December 21, the circumferences of the legs were as follows

	Left	Right
Mid-thigh	40 centimetres	37.5 centimetres
Calf	30 centimetres	27.5 centimetres

At the time he was dismissed on December 24, seventeen days after admission, there was still slight œdema of the leg, but the signs of active phlebitis had disappeared

A reply to an inquiry to this patient July 8, 1932, says his leg swells "just a little," but otherwise, he has had no trouble

*Summary of Case II*—A boy, aged sixteen years, developed an idiopathic phlebitis of the left femoral and left long saphenous veins He was seen

eighteen days after onset when he had pain in the veins, marked tenderness, marked œdema, and fever (temperature,  $101.3^{\circ}$ ) Twenty-four hours after the application of four leeches the pain had disappeared entirely and the œdema had subsided Five more leeches were applied forty-eight hours after the first application and the following day, three more, making a total of twelve leeches The illness was complicated by an infected vaccination The vein remained palpable and the œdema, though less marked, persisted, but within four days after admission, the signs of active phlebitis had disappeared

CASE III—J R, white, male, aged sixty-nine years, unemployed, was admitted to the Charity Hospital December 26, 1931 Twelve days before admission he developed pain and tenderness of the inner anterior aspect of the left thigh in the region of Scarpa's triangle The patient stated that he had had no fever His left leg became and remained swollen Examination revealed marked œdema of the left leg and hard, palpable, tender, long saphenous and femoral veins in the left Scarpa's triangle His temperature was normal

December 28 the swelling, pain and tenderness were still present Five leeches were applied to the inner aspect of the left thigh

The following day, December 29, the œdema had subsided and the pain and tenderness had abated Temperature remained normal Circumferences of the legs were as follows

	Right	Left
Middle third of thigh	50.5 centimetres	54.5 centimetres
Calf	33.5 centimetres	38.6 centimetres

Four more leeches were applied to the inner side of the left thigh along the course of the long saphenous vein

December 30 the œdema had subsided even more, there was less tenderness over the thrombosed vein and the vein was not as indurated as it was prior to the application of the leeches

December 31 four leeches were applied to the inner side of the left thigh Coagulation time,  $2\frac{1}{4}$  minutes, Bleeding time,  $1\frac{1}{2}$  minutes Slight œdema persisted, otherwise, the patient had no complaints The signs of inflammation in the vein had disappeared January 4, 1932, the femoral vein was no longer palpable The hard, cord-like induration had disappeared On January 7, the circumference of the legs recorded in inches were as follows

	Right	Left
Middle third of thigh	45.7 centimetres	52.7 centimetres
Calf	34.1 centimetres	35.5 centimetres

The vein was soft and the signs of inflammation had disappeared, but some œdema of the leg persisted even to the time the patient was discharged January 18, 1932 He was advised to wear a cotton-silk elastic bandage to control the œdema

We had a written reply from the patient July 12, 1932, to an inquiry concerning his condition He is a barber and his leg still swells if he stands on it a long time, but he doesn't wear the elastic bandage Otherwise, he has no other indication of the trouble

*Summary of Case III*—A male, aged sixty-nine years, developed a phlebitis of the left internal saphenous and left femoral veins Leeches (five) were applied fourteen days after the onset when there was pain, marked œdema, tenderness, and a palpable hard vein Twenty-four hours after the

application, the œdema, pain, and tenderness had abated. Eight more leeches were applied in the next forty-eight hours. The signs of inflammation disappeared and the vein softened and became no longer palpable. The œdema persisted, but otherwise the patient was clinically cured in four days.

One examination of the coagulation and bleeding time on the day that the last application of leeches was made showed these to be within normal limits.

CASE IV—M. M., male, aged forty-six years, watchman, was seen first May 21, 1932. He had had varicose veins for nine years. He complained of a tender, painful, red area on the right leg, which had started about ten days prior to registration.

He was a well-developed man. On the anteromedial aspect of the right leg just below the knee was a tender, reddish area, six by six centimetres. The subcutaneous veins in this region stood out prominently. They were tortuous and the veins below this level were full. The veins in the area of tenderness were hard and had the consistency of rope. It was obvious that thrombosis had occurred. There was no appreciable œdema of the foot.

His temperature was 98.8°. He was sent to the hospital (Touro Infirmary). Four leeches were applied in the region of the thrombosis. On the following day, May 22, there was obvious improvement. The redness and tenderness were less marked. His temperature was highest (98.8°) at 4.00 P. M.

May 23 the redness and tenderness had abated even more. The hard vein was still palpable. Temperature remained normal. Three more leeches were applied in the region of the thrombosis.

May 24 the hard vein had softened. The extent of the palpable thrombus was about one-fifth its size on admission. There was one small reddish area, two by two centimetres, with an underlying hard vein, but there was no pain or tenderness. Four more leeches were applied. May 25 and 26 the hard area was still softer. The signs of inflammation had disappeared. May 29 he was dismissed from the hospital. The vein was still palpable but there was no evidence of inflammation.

June 2 he returned to the office. The original thrombosed vein was still palpable and was very slightly tender at the upper end. He had taken his temperature daily and had had no fever. There was a new, reddish, tender area, three by four centimetres, in diameter on the inner side of the right calf about two and one-half inches from the area of the original thrombosis. There was very slight œdema of the foot.

June 4 there were two new areas of phlebitis separate from the first area. One had been noted two days before, the other was anterior on the skin of the right leg at the junction of the middle and lower thirds. Both of these were tender and the underlying vein was palpable, giving the sensation of a hard cord. He was readmitted to the hospital. On the same afternoon, five leeches were applied, three over the upper area and two over the lower area of phlebitis.

On the morning of the following day (June 5, 1932), the redness and tenderness had disappeared from the lower area. There was still a little tenderness in the upper area. Another leech was applied to this area. The afternoon of the same day, the tenderness was almost entirely gone. The patient complained of itching in the region of the leech bites. On the same afternoon it was observed that all evidence of phlebitis in the lower area had entirely disappeared. The vein was not even palpable. The upper area of phlebitis showed some redness. A small, tender, cord-like vein was palpable. Three leeches were applied to the upper area and one to the lower area.

On the following day there was no remaining evidence of phlebitis in the lower area. The upper was still nodular, but there was no tenderness and the erythema had almost completely disappeared. Temperature rose to 99°. Except for this time and the tem-



perature of 99° on the first day of this admission, he had had no fever. He was dismissed from the hospital June 7, 1932.

Of temperatures taken at 8 A.M., 4 P.M., and 8 P.M., the highest recorded was at 4 P.M., June 8 (98.8°). June 9, in the area in which the phlebitis was first noticed, a hard, cord-like vein was palpable, though it was not tender or red. There was also a small palpable nodule, three by three centimetres, in the second area above and internal to this. This likewise was not red or tender. The third area, i.e., at the junction of the middle and lower thirds of the leg, showed no evidence whatsoever of the preexisting phlebitis. He returned to work June 11, 1932. July 5 he was seen again. The nodules were still palpable in the first and second areas, otherwise, there was no evidence of his former trouble. The scars of the leech bites were still present as little reddish tridate marks.

*Summary of Case IV*—A man, aged forty-six years, who had had varicose veins for nine years, developed an area of phlebitis and was seen ten days after the onset. Twenty-four hours after the first application of four leeches, the signs of active phlebitis had strikingly abated. This improvement was even more marked in forty-eight hours. On the third and fourth days of treatment, two more applications of three and four leeches were made and the thrombus began to soften. The signs of inflammation disappeared, but the thrombosed vein remained palpable.

The patient subsequently developed two new areas of phlebitis. Both were treated with leeches, one on the third or fourth day after onset, the other on the first or second day. A total of ten leeches were applied to the two areas. Within twenty-four hours after the application of three leeches to the first area and two to the second, the signs of inflammation had markedly abated in the one and disappeared from the other. The veins softened, and the patient was clinically cured of the second and third areas of phlebitis within three days.

An eosinophilia was noted and it was questionable whether this was attributable to the parasitic leeches, but strongyloides were found in the faeces and this is probably the true cause of the eosinophilia.

Repeated examinations were made of the bleeding and coagulation times, but no applicable changes were noted at any time after the application of the leeches.

*Discussion of Results*—None of our cases belonged to the class in which the treatment of phlebitis with leeches will be most frequently employed, i.e. puerperal and post-operative phlebitis.

Case I in our series was inadequately treated. It was a case of thromboangitis obliterans and the first case of its kind, as far as we know in which leeches have been used, though this has been suggested by Mouzon. We applied leeches with the idea of softening a recent thrombosis in the popliteal vein. It is apparent to us now that an insufficient number of leeches were applied to make it a fair test.

In our Cases II, III, and IV the leeches were applied eighteen, fourteen, and ten days, respectively, after the onset of phlebitis. In all cases, the acute symptoms were still present at the time of the application and improvement

was observed within twenty-four hours and disappearance of the signs of active phlebitis within a few days. In Case IV two other areas of phlebitis developed while the patient was under observation. To one area, leeches were applied twenty-four hours after onset. All evidence of the phlebitis, even the hardness of the vein rapidly disappeared.

The effect of leeching in phlebitis was more pronounced the earlier the first application was made after the onset of phlebitis. The following good results were noted: (1) Rapid disappearance of pain. (2) Disappearance of tenderness. (3) Subsidence of œdema. (4) When the thrombosis was not too long standing the clot softened and objective evidence of its presence disappeared. (5) The fever subsides. This was not so striking in our cases, although the effect was observed. (6) The duration of the phlebitis was shortened. (7) The danger of pulmonary embolism was probably decreased.

*The Effect of Leeching*—Leeches found throughout the world, mostly aquatic but sometimes terrestrial, secrete a substance in their pharynx and œsophagus which is capable of interfering with coagulation of mammalian blood. This substance is known as hirudin. It is supposedly a dutoalbumose (Chavannaz and Magnant), is soluble in water and insoluble in alcohol and ether and is thermostable, therefore not an enzyme (Haycraft). It is supposed to exert its action by combining with thrombin in a manner analogous to a weak acid-base compound in solution (Barratt).

Hirudin is non-toxic to animals, even in doses sufficient to completely prevent coagulation of the blood. Bodong has administered fifty-one milligrams per kilo of body weight to animals without any influence on the pulse, blood-pressure or respiration. Loeffler did not notice any untoward effects after administration of as much as 62 milligrams per kilo of body weight to a rabbit. Eight milligrams of hirudin will render from fifty to sixty cubic centimetres of rabbit's blood incoagulable (Hamm and Schwartz). Approximately seven to eight milligrams of hirudin may be obtained from the head of one leech (Hamm and Schwartz). Apparently, many leeches may be applied without severe untoward results, how many, we are not sure, but certainly more than eighteen. Hamm and Schwartz state that in cases of puerperal phlebitis they did not hesitate to use four to six series of five to eight leeches each at intervals of twenty-four, thirty-six or forty-eight hours. Thorndike says a physician once wrote to him that he had applied two or three dozen leeches to a woman's abdomen for general peritonitis. He stated that it did no good.

Leeches seem to be specific in the treatment of phlebitis. In the initial stage, the application of six to eight leeches is almost sure to meet with a dramatic success. Tholen emphasized the necessity of applying leeches early in phlebitis. He applied leeches as soon as the patient complained of a feeling of heaviness in the leg, local tenderness and a slight increase in temperature and pulse rate. The pain disappears, the fever subsides, the œdema regresses and the local symptoms, *i.e.* the redness, tenderness, and the palpable thrombosed vein, all abate in twenty-four hours and may entirely dis-

appear within forty-eight hours. The thrombus virtually dissolves under one's eye as we have observed a clot do *in vitro* when hirudin is dissolved in its serum.

When thrombosis is well established and has been present for days, the results are still good. If inflammation is still present, the pain, redness, and tenderness disappear though more slowly than after application of leeches for a more recent thrombus. The palpable thrombosed vein may persist if the clot has been present some time as is seen in the first and second areas of thrombosis in our Case IV.

Good results from the leech treatment of thrombophlebitis have been reported by the following authors: Termier, Julliard, Gonnet, Jeannin and Josserand, Beguier, Tholen, Hamm and Schwartz, di Pace, Vidal, Ducuing, Sulger and Boszin, Muresanu, Rossi, and Chahier.

A dissenting opinion was given by Chavannaz and Magnant, who reported ten cases of thrombophlebitis treated by leeches with two deaths from pulmonary embolism. They did not state the number of leeches used, however ten Berge reported a case of thrombophlebitis treated by only two leeches. Death occurred from pulmonary embolism. The treatment was obviously inadequate. These three deaths from embolism occurring after leech treatment for thrombophlebitis are the only ones we find recorded in the literature. A total of 256 cases of thrombophlebitis treated with leeches are reported in the literature. It is hardly fair in evaluating the method to include cases which are not adequately treated, but even then, the incidence of fatal pulmonary embolism following thrombophlebitis treated with leeches is 1.2 per cent which compared with the incidence of 15.9 per cent, fatal embolism following femoral thrombophlebitis as reported by Albanus probably indicates decided improvement. (It is possible that these figures are incorrect. There were other deaths in the series but whenever it was not stated definitely that a death was due to pulmonary embolism, it was not counted as such.)

*The Rationality of the Leech Treatment of Phlebitis*—It has never been accurately determined just how the leech treatment acts beneficially in thrombophlebitis. Termier ascribes the excellent effect of the leech treatment to a simple dissolution of the blood-clot. We have observed a blood-clot dissolve *in vitro* after the addition of hirudin. This effect of hirudin has been demonstrated before (Hamm and Schwartz). Jeannin produced chemical phlebitis in animals by the intravenous injection of sodium salicylate. In those which he also gave intravenous or subcutaneous injection of hirudin, no thrombus formed, even though there was nearly complete desquamation of the endothelium of the vein at the site of injection, whereas thrombosis did occur in the control animals. Sulger and Boszin think the good results of the leech treatment are due to local blood letting. Hamm and Schwartz believe that the application of leeches in phlebitis may stop venous spasm and by this, the propagation of the thrombus. Henschen (quoted by Sulger and Boszin) is of the opinion that the good effects of leech treatment in phlebitis are due to general hirudinization.

Termier, Weil and Boyé Mouzon, Gonnet, Jeannin and Josserand, Hamm and Schwartz, Chavannaz and Magnant, Tholen, all state that the systemic coagulation time is prolonged after the application of leeches. Ducuing and Sulger and Boszin are of the contrary opinion. Sulger and Boszin studied the coagulation time in thirty-three cases treated with leeches. It was increased in seven cases, shortened in nine, and unchanged in seventeen. The same authors studied the bleeding time in twenty-seven cases. It was increased in thirteen, shortened in three, and unchanged in eleven. The bleeding time in three and the coagulation time in two of our cases were within normal limits after the application of leeches. These were the only instances in which such determinations were made by us.

Sulger and Boszin examined the blood platelets in twenty-seven cases. They were increased in five, decreased in seven, and unchanged in fifteen. The same authors found that post-operative leucocytosis and decreased sedimentation time occurred no more frequently after the application of leeches than when they were not applied. They believe that leeches when applied as advocated had no appreciable effect on the systemic blood. Bosc and Delezenne were of the opinion, based on animal experimentation, that hirudin when added to blood inhibited the growth of organisms *in vitro* and *in vivo*.

We are now conducting some experiments to determine the mode of action of hirudin. We think the good results of the leech treatment in phlebitis may be attributed to several effects. There is probably a real softening of an early thrombus. The mild bleeding probably has some beneficial effect and the striking alleviation of pain is possibly due to the above, possibly to an anti-spasmodic or even more doubtful, a local analgesic action on the nerves. From the work of Bosc and Delezenne, it may be possible that hirudin actually interferes with the growth of microorganisms by assisting the defensive mechanism of the blood.

*The Disadvantages of Leech Treatment*—Leeches, like snakes, are not pleasant to look at and create in most individuals a feeling of revulsion even when viewed. Undoubtedly to many, even the less esthetic individuals, the thought of application of leeches will be repulsive. The objection, while it may be outweighed by benefits which the method promises, is nevertheless a real one. Perhaps it will be possible to standardize a method of introducing hirudin which will replace the use of leeches. Ducuing has used hirudin intravenously in the treatment of phlebitis, but he does not compare the efficacy with the application of leeches.

Local bleeding is another disadvantage in leeching, especially in an anæmic person. A leech sucks about fifteen cubic centimetres of blood but the bites continue to ooze and Sulger and Boszin report an increase in the weight of bandages up to 500 grams after the application of several leeches. We have not encountered any great difficulty in this respect. A tight bandage seems to adequately control hæmorrhage.

While there are conflicting reports in the literature as to a change in the coagulation time of the systemic blood, the weight of evidence is that no appreciable effect is exerted on the blood throughout the body and that there is no danger from secondary hæmorrhage after operation or delivery when leeches are applied peripherally. We find no reports of secondary hæmorrhages from wounds or from the uterus after leeches have been applied.

Local itching and generalized urticaria (Chavannaz and Magnant and Mouzon) occasionally occur after leech application. Urticaria is apparently uncommon. One of our patients had local itching. It was mild.

Infection following the bite of the leech does not seem to be a real danger. We have found several allusions in the literature to the protective effect of hirudin against infection. While this has not been adequately proven, the work of Bosc and Delezenne would indicate that this is true. Sulger and Boszin who have applied leeches many thousand times as a prophylactic and therapeutic measure seldom saw infection and when it did occur, it was easily controlled by hot applications and immobilization.

The possibility of liberating organisms by dissolution of an infected thrombus is theoretically an objection to the leech treatment of phlebitis but in practice, this has apparently not been an actuality. Sulger and Boszin did not find any increase of embolism which may have been attributed to a softening of the thrombus by hirudin.

*The Possibilities of Hirudination*—Possibly in the future, if the mass of evidence placing a high value on the use of leeches in phlebitis continues to be confirmed, a more scientific method of hirudination will be evolved. This entails elaboration of an injection technic and standardization of a dose. Apparently hirudin is not toxic to the organism and this opens numerous possibilities for its use. One might even imagine that by hirudination, the freshly precipitated thrombus in the cerebral or coronary vessels might be softened and this is especially a likelihood if temporary elevations of the coagulation time to say ten or fifteen minutes will result in dissolution of a clot *in vivo* as the addition of hirudin does *in vitro*. Here the accuracy of an exact pathological diagnosis would be seriously called into question for if the symptoms were occasioned by a hæmorrhage instead of a thrombosis, hirudin would not only not be indicated, but it would be actually contra-indicated. In rapid progress in thrombo-angitis obliterans, elevation of the systemic coagulation time would probably abate the progress of the disease. The action of hirudin would be temporary. It would be interesting to note the effect and apparently it could be attempted with safety.

*The Use of Leeches Post-operatively as a Prophylactic Measure Against Phlebitis*—Leeches have been used post-operatively as a measure to prevent the occurrence of phlebitis by Hamm and Schwartz, Termier, Sulger and Boszin. Hamm and Schwartz have used three leeches on the fourth and two more on the seventh post-operative day. They recommend the application of leeches as early as the third post-operative day. Sulger and Boszin published some valuable figures on the comparative value of this method. One group of 3,264 operated cases were not treated prophylactically with leeches, 192 died, 145 were autopsied and among this group, there were nineteen deaths from embolism. In a similar group treated prophylactically, there were 3,316 operated cases, 187 died, 140 were autopsied, and eighteen died of pulmonary embolism. They concluded that leeches did not prevent the development of thrombosis. Leeches in small numbers do not appreciably affect the coagulation time of the blood in the systemic circulation. Effects of mild doses of hirudin on the coagulation time of the blood are not prolonged. Josserand and Jeannin found that when the coagulation time of a rabbit was prolonged from four to twenty-one minutes by the subcutaneous injection of hirudin

## LEECHES IN TREATMENT OF PHLEBITIS

at the end of twenty-five hours, the coagulation time was again practically normal (four and one-half minutes) Hirudin is excreted by the kidneys and may be destroyed in the body

The report of Sulger and Boszin would indicate that leeches, at least in the numbers advocated, are not of value as a preventive measure against post-operative thrombosis In larger numbers, their use is probably not justified as a routine prophylaxis after operation The apparent discrepancy between the negative results obtained from the prophylactic use of leeches of Sulger and Boszin and the beneficial results obtained therapeutically in the present series, and those of others, is probably due to the fact that when used in the treatment of phlebitis, the leeches are applied directly over or at least in the immediate vicinity of the involved vein We believe from our own investigations, which substantiate those of Ducuing and Sulger and Boszin, that the application of leeches does not effect the coagulability of the systemic blood If such a premise is correct, the application of leeches post-operatively would in no way effect thrombosis or thrombophlebitis except in the veins in the immediate vicinity of the leeches

**SUMMARY**—Available statistics show that fatal pulmonary embolism accounts for approximately 6 per cent of surgical deaths Various measures to reduce this incidence have been advocated Teimer, in 1922, revived a leech treatment of phlebitis and reported excellent results Many authors of Europe have used and advocated this method of treatment

We have used leeches in the treatment of phlebitis in four cases One was a case of thrombo-angitis obliterans in which there was a recent thrombosis of the popliteal vein The number of leeches applied was inadequate and without benefit In three cases of phlebitis occurring in men, the application of leeches resulted in rapid abatement of the symptoms, and an early cure

The good effects of the leech treatment of phlebitis are (1) Rapid disappearance of pain (2) Disappearance of tenderness (3) Subsidence of oedema (4) When the thrombosis is not too long standing, the clot softens and objective evidence of its presence disappears (5) Fever subsides (6) The duration of phlebitis is shortened (7) The danger of pulmonary embolism is markedly decreased

We recommend the leech treatment as the best available method of treating phlebitis and of diminishing the dangers of pulmonary embolism

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## ARTERIAL EMBOLLECTOMY

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(CONTINUED FROM PAGE 272)

The most commonly affected vessel of the lower extremity in our series is the femoral, fifty-two, next in frequency is the common iliac, eighteen, following that is the popliteal, twelve. The least frequently affected are the anterior and posterior tibials. The infrequency of embolic lodgment in these two vessels is probably due to the fact that an embolus reaching down to the popliteal becomes arrested at the bifurcation and very seldom enters either one of the two branching vessels.

Out of the eighteen cases of embolic obstruction of the common iliac, seventeen were operated on and the circulation was completely restored in five, or 29.4 per cent. In one of these patients, a bilateral embolectomy was done through an abdominal incision and complete recovery followed, with the exception of some muscle weakness in one leg. One of these patients was re-operated on one month later for obstructive symptoms on the operated side. The constriction was relieved followed by complete cure. Three of these patients were operated on between one and nine hours after the onset and the time is not stated in two.

There were five operations upon the internal and external iliac vessels, of which two cases, operated on between two and three hours, completely recovered. The embolus was lodged in the left external in one, and the right external iliac in another.

Fifty-one embolectomies were performed on the femoral artery out of the fifty-two cases. In fifteen, or 29.4 per cent, the circulation was completely restored. Ten of these cases were operated on between one and ten hours after the onset, three between fifteen and twenty-seven hours, and in two the time was not stated. In one of these patients an embolectomy was performed on the opposite side, fourteen months before, followed by complete recovery. Another one had a bilateral arteriotomy with successful circulatory restoration on both sides. This would indicate that the chances for circulatory restoration in the femoral artery are very good, provided the operation is done very early.

Eleven embolectomies were performed on the popliteal vessel, and in five, or 45.4 per cent, the circulation was successfully restored. Four of these cases were operated on between nine and twelve hours, and in one the time is not stated. It is worthy of note that the percentage of circulatory restoration in this vessel is much higher than in the femoral or the iliacs. This may be attributed to the rich collateral circulation present about the knee-joint, as stated previously.

# ARTERIAL EMBOLECTOMY

## VESSELS OF THE LOWER EXTREMITY—FEMORAL CASES

CASE I—Side not stated Female, aged sixty-seven, suffered from arteriosclerosis Operated on twelve hours later under local anæsthesia, gangrene of foot developed, Chopart amputation of foot, good stump In this case, two incisions were made, one in the femoral and one in the popliteal Thrombus, forty centimetres long, was extracted The low location of gangrene is attributed to the establishment of collateral circulation<sup>20</sup>

CASE II—Left femoral Male, aged sixty-six, suffered from arteriosclerosis Operated on two hours later under spinal anæsthesia, followed by complete circulatory restoration Patient was in good health three months later<sup>21</sup>

CASE III—Right femoral Female, aged forty-one, suffered from cardiac disease Operated on sixteen hours after onset of symptoms under local anæsthesia There appeared to be some partial restoration of circulation Patient died twenty-four hours later<sup>24</sup>

CASE IV—Left femoral Female, aged sixty-nine, suffered from cardiac disease Operated on ten hours after onset of symptoms under general anæsthesia Died twenty-one hours after operation<sup>24</sup>

CASE V—Right femoral Female, aged fifty-two, suffered from cardiac disease Operated on ten hours after onset of symptoms under local anæsthesia Gangrene developed, necessitating amputation, one week later Died thirty-three days after operation This patient had symptoms of an embolus in the same vessel a week before, but the symptoms subsided spontaneously<sup>24</sup>

CASE VI—Right femoral Female, aged twenty-seven, cardiac Operated on six hours after onset of symptoms under local anæsthesia, unsuccessfully Died three hours later Post-mortem examination showed thrombosis in right common femoral artery up to the bifurcation of the aorta and down to the external and internal iliacs on the left side<sup>23</sup>

CASE VII—Right femoral Male, aged thirty-six, was operated on for jejunal ulcer Third day patient developed symptoms of pulmonary embolism Operated on twenty-four hours later under ether anæsthesia, embolus removed, gangrene developed, and amputation was done Dissection of leg showed thrombus in femoral artery, extending to the lower third of femoral Femoral vein was also thrombosed throughout its entire length Three years later patient showed symptoms of obstruction of the left femoral artery and the peripheral vessels of the foot<sup>19</sup>

CASE VIII—Left femoral Female, aged fifty-six, suffered from arteriosclerosis and diabetes Operated on twenty-eight hours after onset of symptoms under ether anæsthesia, followed by gangrene and amputation of leg In this case there was no pulsation of the vessel after removing the embolus, incision was re-opened and another clot extracted, again there was no free flow of blood Segment of vessel was then resected, but the circulation not restored<sup>10</sup>

CASE IX—Left femoral Male, aged fifty-five, etiology, asthma and hypertension Patient was not operated on, developed gangrene of thigh, necessitating amputation<sup>8</sup>

CASE X—Left femoral Female, aged thirty-nine, cardiac disease Operated on under local anæsthesia, six hours after onset, followed by complete circulatory restoration Died two weeks later from cerebral embolism This patient had an embolus of the right femoral, eleven days previously, which was undiagnosed until gangrene developed, necessitating amputation of right thigh<sup>4</sup>

CASE XI—Side not stated Female, aged sixty-four, cardiac Operated on fifteen hours after onset, unsuccessfully, under novocaine anæsthesia Gangrene of leg developed, died twelve days later, no autopsy<sup>3</sup>

CASE XII—Side not stated Female, aged fifty, suffered from cardiac disease and hypertension Operated on twenty-four hours after onset of symptoms under novocaine anæsthesia Thrombus, ten one-half inches long, milked out from vessel at operation Gangrene developed followed by amputation<sup>2</sup>

CASE XIII—Left femoral Female, aged forty-seven, operated on for thyrotoxicosis Operated on one hour after onset under ethylene anæsthesia, followed by gangrene on fourth day Died eight days after operation from secondary emboli<sup>39</sup>

CASE XIV—Left femoral Male, aged sixty, cardiac Operated on twenty-seven hours later under local anæsthesia, followed by complete circulatory restoration Patient suffered from previous renal embolism Died seven days later from an attack of angina pectoris Autopsy showed coronary sclerosis, embolism and secondary thrombosis of the femoral artery<sup>27</sup>

CASE XV—Left femoral Female, aged forty-four, cardiac Operated on ten hours later under local anæsthesia Gangrene developed, died thirteen days later There was distinct popliteal pulsation three hours after operation, which disappeared later on, probably through reformation of thrombus<sup>11</sup>

CASE XVI—Right femoral Female, aged seventy, cardiac Operated on two hours after onset under local anæsthesia Gangrene developed, necessitating amputation of thigh Died on the fourth day Dissection of leg showed femoral and profunda free from clots Saddle embolus at bifurcation of popliteal into anterior and posterior tibial arteries Operated on ten days before for an axillary embolus, followed by complete circulatory restoration and function of arm and forearm<sup>13</sup>

CASE XVII—Side not stated Female, aged seventy Etiology not stated Operated on eleven hours later Anæsthesia not stated Patient developed gangrene and died two days later from general arteriosclerosis<sup>3</sup>

CASE XVIII—Side not stated Male, aged sixty Etiology not stated Operated on nine hours later, anæsthesia not stated Died three days later from septic thrombosis, circulation not restored<sup>35</sup>

CASE XIX—Side not stated Female, aged thirty-eight, etiology not stated Operated on six hours after onset, anæsthesia not stated Died within a month There was some partial circulatory restoration<sup>35</sup>

CASE XX—Left femoral Female, aged sixty-seven, cardiac Operated on under local anæsthesia, four hours after onset, followed by complete cure<sup>64</sup>

CASE XXI—Right femoral Female, aged fifty-nine, cardiac Operated on one hour after onset of symptoms under local anæsthesia, followed by complete circulatory restoration Died one month later from pulmonary embolism Autopsy showed narrowing of the artery at the arteriotomy incision, and thrombosis of left extremity<sup>66</sup>

CASE XXII—Left femoral Female, aged forty-one, cardiac Operated on two hours after onset of symptoms Type of anæsthesia not stated Circulation and function were restored Had two previous attacks of pulmonary embolism<sup>60</sup>

CASE XXIII—Right femoral Female, aged forty-two, cardiac Operated on two hours after onset of symptoms under local anæsthesia Circulation and function restored Six months later patient perfectly well Submitted to two embolectomies during the course of fourteen months, with successful outcome<sup>60</sup>

CASE XXIV—Left femoral Male, aged fifty-four, suffered from arteriosclerosis Operated on twenty-four hours later, anæsthesia not stated Gangrene and amputation of thigh<sup>57</sup>

CASE XXV—Bilateral femoral embolectomy Female, aged sixty-four, cardiac Time of operation and anæsthesia not stated Circulation and function restored on both sides<sup>67</sup>

CASE XXVI—Right femoral Male, aged forty-eight Etiology, alcoholic? Operated on twenty-four hours after onset under general anæsthesia followed by gangrene and amputation Artery was not incised, pulsation was restored in femoral by massage, gangrene, which developed subsequently, may have been caused by displacing the embolus downwards<sup>66</sup>

CASE XXVII—Right femoral Male, aged seventy-three, suffered from angina pectoris Operated on two hours later under local anæsthesia, gangrene and amputation two days later Dissection of leg showed popliteal and femoral arteries packed with red thrombi Patient developed a cerebral embolus later on, from which he recovered<sup>66</sup>

## ARTERIAL EMBOLLECTOMY

CASE XXVIII—Right femoral Male, aged twenty-two, cardiac Operated on seventy-two hours later under local anæsthesia, followed by gangrene and amputation Died three days later, post-mortem examination showed obstructing thrombi in femoral artery Femoral vein was also extensively thrombosed<sup>62</sup>

CASE XXIX—Side not stated Male, aged fifty-eight, cardiac Operated on seventeen hours after onset, under local anæsthesia, followed by gangrene and amputation<sup>61</sup>

CASE XXX—Female, aged thirty, cardiac Operated on under local anæsthesia one hour after onset of symptoms Circulation and function restored<sup>61</sup>

CASE XXXI—Right femoral Female, aged sixty-two, suffered from diabetes and cardiac disease Embolus followed operation for toxic goitre Operated on four hours after onset of symptoms, under local anæsthesia, followed by partial restoration of circulation Five days later she developed an embolus at the aortic bifurcation for which she was operated on and died on the following day<sup>60</sup>

CASE XXXII—Right femoral Male, aged fifty-three, cardiac Operated on under spinal anæsthesia, time elapsed not stated Gangrene developed, necessitating amputation Patient died on fifth day Post-mortem examination showed thrombi of both iliacs and femoral arteries, with complete obstruction of the lower branches of the mesenteric artery, thrombus of ascending portion of aortic arch<sup>48</sup>

CASE XXXIII—Male, aged sixty-five, cardiac Operated on seven hours after onset of disease under local anæsthesia Complete restoration of circulation and function Had a previous renal embolism Died a cardiac death eight months after operation<sup>49</sup>

CASE XXXIV—Left femoral Female, aged sixty-two, cardiac Operated on eighteen hours after onset of disease under local anæsthesia Two incisions were made in this case, one in femoral and one in popliteal, on account of the thrombus slipping down from femoral to the popliteal Circulation and function restored<sup>45</sup>

CASE XXXV—Bilateral femoral embolectomy Female, aged thirty-eight, cardiac Operated on sixteen hours after onset under local anæsthesia Died twenty-four hours later<sup>41</sup>

CASE XXXVI—Left femoral Male, aged fifty, suffered from cardiovascular disease Operated on twelve hours after onset under local anæsthesia Patient developed gangrene and died<sup>44</sup>

CASE XXXVII—Left femoral Male, aged forty-one, operated for nephrectomy Developed an embolus twelve hours after operation Operated on four hours later under spinal anæsthesia, developed gangrene, died twenty-four hours later Post-mortem examination showed embolus in iliac artery, extending into hypogastric, no new thrombus in renal artery<sup>57</sup>

CASE XXXVIII—Left femoral Male, aged fifty-six, cardiac Operated on fifteen hours later under local anæsthesia followed by complete restoration of circulation and function Return of circulation was rather slow but ultimately there was complete recovery Discharged well thirty-eight days after operation<sup>71</sup>

CASE XXXIX—Female, aged fifty-six, cardiac Operated on three hours later under spinal anæsthesia Patient died twenty-four after operation following secondary emboli in radial artery<sup>75</sup>

CASE XL—Bilateral femoral embolectomy Female, aged forty, cardiac Operated on under general anæsthesia, time elapsed not stated Death took place within thirty-six hours from secondary emboli<sup>29</sup>

CASE XLI—Right femoral Female, aged seventy-eight, suffered from cardiovascular disease Operated on twenty-four hours after onset of disease, under novocaine anæsthesia Gangrene developed, died two days later Both legs became affected, probably from the extension of the thrombus to the other side<sup>2</sup>

CASE XLII—Right femoral Male, aged twenty-five, cardiac Operated on four hours later under local anæsthesia Circulation was restored Patient well six months later<sup>1</sup>

CASE XLIII—Left femoral Female, aged thirty-two, cardiac Operated on twenty-three hours later under local anaesthesia Gangrene developed, necessitating amputation Dissection of vessel showed small thorn-like embolus in anterior tibial artery <sup>78</sup>

CASE XLIV—Right femoral Female, aged eighty-two, had a previous hemiplegia and aphasia Operated on five hours after onset of symptoms under local anaesthesia, circulation was completely restored, patient well one year later, able to walk without any discomfort <sup>78</sup>

CASE XLV—Left femoral Female, aged seventy-seven, cardiac Operated on 108 hours after onset under local anaesthesia Developed gangrene and died nine days later Autopsy showed complete obstruction of femoral, popliteal and tibial arteries <sup>78</sup>

CASE XLVI—Female, aged fifty-three, hysterectomy operation Operated on seven hours later, anaesthesia not stated Gangrene developed to the hip Disarticulation of hip-joint performed five days later Died a few hours after operation, no autopsy <sup>7</sup>

CASE XLVII—Female, aged fifty-six, cardiac Operated on six hours later under general anaesthesia Developed gangrene requiring amputation of thigh seven days later <sup>78</sup>

CASE XLVIII—Male, aged twenty-nine, cardiac Operated on under novocaine anaesthesia twenty-six hours after onset, gangrene developed, amputation three days later <sup>78</sup>

CASE XLIX—Right femoral Male, aged sixty-five, cardiac Operated on under local anaesthesia, time elapsed not stated Complete circulatory restoration Patient well three months later, no appreciable atrophy of limb <sup>69</sup>

CASE L—Right femoral Male, aged fifty-two, cardiac Operated on twelve hours later under spinal anaesthesia Died three hours later <sup>64</sup>

CASE LI—Left femoral Female, aged forty-six, operated on for appendicitis Embolectomy performed ten hours after onset under general anaesthesia Gangrene developed requiring amputation and patient died two weeks later <sup>64</sup>

CASE LII—Left femoral Male, aged fifty-six, cardiac Operated on under spinal anaesthesia three hours later, gangrene developed, amputation performed Patient left hospital in good condition <sup>64</sup>

#### VESSELS OF THE LOWER EXTREMITY—COMMON ILIAC CASES

CASE I—Right common iliac Female, aged thirty Cardiac embolus followed hysterotomy operation Operated on ten hours later under novocaine anaesthesia, gangrene developed, amputation at mid-thigh performed Died one week later from pulmonary embolus <sup>2</sup>

CASE II—Right common iliac Female, aged forty, suffered from cardiac disease Operated on under novocaine anaesthesia forty-eight hours after onset, gangrene developed necessitating amputation Death took place ten days later from a pulmonary embolus <sup>76</sup>

CASE III—Left common iliac Male, aged fifty-three Post-operative course followed a nephrotomy Operated on under spinal anaesthesia, time elapsed from onset of symptoms not stated Patient died twelve hours after operation from a pulmonary embolus <sup>67</sup>

CASE IV—Left common iliac Male, aged forty-six, suffered from cardiac disease Operated on four hours later under local anaesthesia Subjective symptoms disappeared at once, but it took several hours for any pulsation to be felt in the popliteal space, which might have been due to a contracted femoral artery below the incision The circulation and function were restored <sup>62</sup>

CASE V—Bilateral common iliacs Male, aged sixty-eight, suffered from cardiovascular disease Patient was not operated on An attempt was made to milk the emboli down into the femoral There was no restoration of circulation, patient died twenty-four hours later Post-mortem examination showed thrombosis of both femoral arteries, indicating the futility of such a procedure <sup>57</sup>

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CASE VI—Bilateral common iliacs Female, aged fifty-six, suffered from thrombosis of right iliac vein. Patient was operated on but neither the time elapsed after the onset of disease nor the anæsthesia is stated. Died seven hours later from cerebral emboli. This is probably a case of paradoxical embolism following thrombosis of the right iliac veins<sup>67</sup>

CASE VII—Bilateral common iliacs Female, aged thirty-two. Etiology, time elapsed between onset of symptoms and operation not stated. Operated on under spinal anæsthesia, developed gangrene, died three days later. Post-mortem examination showed thrombi in femoral and tibial arteries on both sides and also pulmonary embolus<sup>43</sup>

CASE VIII—Right common iliac Male, aged thirty-one. The only etiology stated is that the patient had malaria four years before. Time elapsed not stated. Operation performed under spinal anæsthesia followed by complete circulatory restoration. There was some peripheral circulatory disturbance in the left leg some weeks later which improved under conservative treatment. One month after that obstructive symptoms developed on the operated side, re-operated, constriction relieved followed by complete cure<sup>43</sup>

CASE IX—Side not stated. Female, aged forty-four. Etiology, eclampsia gravidarum. Operated on ten hours later under local anæsthesia followed by complete restoration of circulation. There was no distinct discoloration to be seen and patient was able to lift her leg and move both foot and toes before the operation, indicating that there might not have been a complete obstruction of the blood-vessel lumen<sup>46</sup>

CASE X—Bilateral common iliac embolectomy. Female. Age, time elapsed and anæsthesia not stated. Bilateral common iliac embolectomy at the same sitting was done through an abdominal incision with perfect result and complete recovery, except for some muscle weakness in one leg. This patient is walking around and doing all her work several months after her operation<sup>62</sup>

CASE XI—Right common iliac. Female, aged thirty-five, cardiac disease. Operated on under spinal anæsthesia supplemented by general nine hours after onset. Complete recovery, patient well four months after operation<sup>47</sup>

CASE XII—Right common iliac. Male, aged thirty-eight, septic endocarditis. Patient was not operated on, died eight days later. Post-mortem examination showed clot completely obstructing right common iliac. *There was no gangrene*. Circulation probably carried on through an anastomosis existing between terminal branches of internal mammary and the lumbar arteries, also through the circumflex and abdominal branches from the femoral<sup>29</sup>

CASE XIII—Left common iliac. Female, aged fifty-two, cardiovascular disease. Operated on under spinal anæsthesia eight hours after onset of symptoms, developed gangrene and died two days after operation<sup>29</sup>

CASE XIV—Right common iliac. Female, aged thirty-five, cardiac. Operated on under local anæsthesia seven hours after onset. There was a partial circulatory restoration. Twenty-five hours later patient was re-operated for embolus of left femoral. Grew progressively worse and died ten hours after second operation. Author states that circulation in right leg and foot remained good<sup>61</sup>

CASE XV—Left common iliac. Female, aged thirty-five, suffered from cardiac disease and bacterial endocarditis. Cerebral embolus one week before. Operated on under spinal anæsthesia ten hours later. No restoration of circulation, gangrene developed, and patient died several days later from secondary emboli in right popliteal and brain. Patient was very ill at time of operation. Question wisdom of any intervention in such a case<sup>13</sup>

CASE XVI—Side not stated. Female, aged fifty-three. Etiology not stated. Operated on twenty hours after onset followed by partial restoration of circulation. Developed popliteal embolus several days after. Died twelve days after first operation<sup>28</sup>

CASE XVII—Side not stated Female, aged thirty-eight Etiology not stated Operated on six hours after onset Developed gangrene and died within a month<sup>35</sup>

CASE XVIII—Bilateral common iliacs Female, aged thirty-four, cardiac Operated on nine hours later under local anaesthesia followed by partial restoration of circulation Good circulation on left leg, fair on right, which was probably carried on through the collateral branches Died four months later from hemiplegia<sup>44</sup>

VESSLS OF THE LOWER EXTREMITY—POPLITEAL CASES

CASE I—Right popliteal Male, aged thirty-nine The embolus followed a bullet wound in lung Operated on under local anaesthesia twelve hours later Gangrene developed, patient died on the fourth day from pneumonia The arterial clot contained a fragment of lung tissue at its apex<sup>20</sup>

CASE II—Right popliteal Female, aged fifty-four, suffered from diabetes, cardiovascular disease and hypertension Operated on eighteen hours later under general anaesthesia and died fifty minutes after operation<sup>2</sup>

CASE III—Left popliteal Male, aged sixty, suffered from syphilis and arteriosclerosis Operated on eighteen hours later under novocaine anaesthesia followed by gangrene and amputation Died six months later<sup>2</sup>

CASE IV—Right popliteal Female, aged forty-eight, suffered from Graves' disease and typhoid fever Operated on three hours after onset under novocaine anaesthesia Circulation was restored and patient discharged well one month after operation<sup>2</sup>

CASE V—Right popliteal Female, aged forty-two, cardiac disease and previous cerebral embolism Operation performed twelve hours after onset under local anaesthesia Circulation was restored, patient well several months after operation<sup>4</sup>

CASE VI—Male, aged fifty-eight, suffered from cardiac disease Operated on nine hours after onset, anaesthesia not stated Circulation was completely restored Three months later there was good pulsation on the affected side, patient died four months later from secondary emboli<sup>60</sup>

CASE VII—Right popliteal Female, aged fifty-four, suffered from a streptococcus blood-stream infection Operated on under spinal anaesthesia twenty-four hours after onset of symptoms, gangrene developed necessitating amputation of thigh Died four months later, cause was not given<sup>64</sup>

CASE VIII—Female, aged sixty-three, suffered from cardiac disease Had an attack of hemiplegia two days previously Time of operation is not stated Type of anaesthesia, local Circulation was completely restored<sup>58</sup>

CASE IX—Left popliteal Female, aged sixty, suffered from thyrotoxicosis Operated on three hours after onset under local anaesthesia Gangrene developed, amputation was done Died four days later from pneumonia<sup>61</sup>

CASE X—Left popliteal Female, aged sixty-eight History of thyrotoxicosis, while recuperating from a nephrectomy operation developed symptoms of popliteal embolism Expectant treatment applied, no operation, circulation was restored through collateral anastomotic branches<sup>38</sup>

CASE XI—Left popliteal Male, aged thirty-six, cardiac Operated on forty-eight hours later under nitrous-oxide gas anaesthesia An unsuccessful attempt was made to extract the embolus but gangrene developed and amputation above the knee was done Dissection of vessel showed a saddle thrombus at the bifurcation of the popliteal into the anterior and posterior tibial vessels Patient well today<sup>13</sup>

CASE XII—Male, aged sixty-three Etiology is not given Operation performed twelve hours later, anaesthesia not stated Complete restoration of circulation and function<sup>35</sup>

VESSLS OF THE LOWER EXTREMITY—ANTERIOR AND POSTERIOR TIBIALS

CASE I—Bilateral Female, aged twenty-four, suffered from puerperal sepsis and venous thrombosis She was not operated on, developed gangrene in both legs This is

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a case of paradoxical bilateral embolism Post-mortem examination showed a thrombosis of iliac and renal veins<sup>54</sup>

CASE II—Male, aged forty-four Etiology and anæsthesia not stated Operation performed three hours after onset followed by complete restitution of circulation and function<sup>35</sup>

### VESSELS OF THE LOWER EXTREMITY—INTERNAL AND EXTERNAL ILIAC

CASE I—External iliac Female, aged thirty-five, suffered from cardiac disease and bronchopneumonia Operated on (time not stated) under local anæsthesia, followed by partial restoration of circulation Gangrene confined only to the toes There was an improvement in circulation and relief of pain Died two weeks later of infection as result of a burn No extension of gangrene to leg<sup>19</sup>

CASE II—Left external iliac Female, aged forty-four, cardiac Not operated on, gangrene of left leg Died twelve days later Autopsy showed embolus left external iliac and femoral, ball thrombus of left auricle<sup>51</sup>

CASE III—Left external iliac Male, aged forty-eight, cardiac Operated on two hours after onset of symptoms under novocaine anæsthesia followed by complete cure Patient had an embolus lodged in the right femoral several weeks previously which was followed by gangrene necessitating amputation<sup>50</sup>

CASE IV—Right external iliac Male, aged forty-seven, cardiac Operated on twenty-six hours later under ether anæsthesia, gangrene developed, died one week later<sup>47</sup>

CASE V—Right external iliac Male, aged forty-one, cardiac Operated on three hours later under general anæsthesia Patient well Six months later developed cerebral embolus, improved<sup>64</sup>

*Importance of Early Operation*—The importance of early operation is well illustrated in the accompanying Table VIII Out of twenty-nine cases which were operated on between one and four hours, the circulation was restored in eighteen (62 per cent), partial circulatory restoration was obtained in three, seven developed gangrene, and one died immediately after operation before gangrene had a chance to set in

In eighteen cases that were operated on between four to eight hours, there was complete restoration in nine (50 per cent), partial restoration in three, five developed gangrene, and one died immediately after operation

Of twenty-four cases operated on between eight and twelve hours, there were six complete restorations, one partial, ten developed gangrene necessitating amputation, nine of which subsequently died, and seven died soon after operation

In nineteen cases that were operated on between twelve and twenty-four hours, the circulation was restored in four (21 per cent)

There is no authentic case of complete circulatory restoration in the affected vessel of the lower extremity that was operated on forty-eight hours after the onset of the disease In those vessels of the upper extremity operated on successfully forty-eight hours after the onset of the disease, the circulation was probably restored through collateral branches

The case of an embolus supposed to have lodged in the radial artery several days or weeks before the operation bears out this point "Clot was removed from the lowermost portion of the radial artery, patient made a



slow but progressive recovery, perfectly well one year later" Presumably, in this case, there was no circulatory restoration in the lumen of the radial artery The circulation in the arm and forearm must have been restored through collateral branches

TABLE VIII  
*Operative Results of Total Number of Cases in Hours*

Hours	Complete Res-toration Living	Complete Res-toration Sub-sequent Death	Partial Res-toration Living	Partial Res-toration Sub-sequent Death	Gan-grene Ampu-tation Living	Gan-grene Ampu-tation Sub-sequent Death	Death Soon After Opera-tion	Total
1- 4 hrs	13	5	1	2	2	5	1	29
4- 8 hrs	7	2	1	2	1	4	1	18
8- 12 hrs	5	1	1		1	9	7	24
12- 16 hrs	2	1		1		1	1	6
16- 20 hrs	1			1	1	1	1	5
20- 24 hrs					4	4		8
24- 28 hrs		1			2	1		4
28- 48 hrs	2				1	1	1	5
48-108 hrs					1	2	1	4
Several days	1							1
Time not stated	8			1		4	3	16
No operation				3	2	4		9
Totals	39	10	3	10	15	36	16	129

These percentages of cures are still further reduced by the number of subsequent deaths, either during the patients' stay in the hospital or after their discharge, as will be shown later in the text

Are the operative results with relation to time in any way affected by the etiology of the disease? It would be reasonable to expect that in cases where the arterial embolus is purely of cardiac origin, not associated with any disease of the blood-vessel walls, that the operative results would be much more satisfactory—the time element being the same—than in those cases complicated by advanced arteriosclerosis. Similar results would be expected between purely cardiac cases and those associated with thyrotoxicosis, diabetes, syphilis, post-operative conditions, *etc*. Unfortunately, the numerical ratio between the two types of cases is such that comparative statistics may not be of much value.

Analyzing the time element with reference to the etiology in this group of cases, we find that out of thirty-eight cases of purely cardiac origin, which were operated on between one to twelve hours, twenty-one (55 per cent)

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were followed by complete circulatory restoration, two improved, seven developed gangrene, and eight died soon after operation before gangrene set in

In twenty-one cases in which the cardiac condition was associated with other diseases, such as arteriosclerosis, thyrotoxicosis, diabetes, *etc*, which were also operated on between one to twelve hours, in seven ( $33\frac{1}{3}$  per cent), there was complete circulatory restoration, two are listed as improved but died within a few days after operation, eight developed gangrene requiring amputation, seven of which terminated fatally, and four died immediately after operation

Between twelve and twenty-four hours in the purely cardiac group, we find eight cases, of which two (25 per cent) were cured, three died following gangrene and amputation, and three died soon after operation before gangrene set in; while in the other group, operated on within the same hours, there are five cases, in which one (20 per cent) was cured, three developed gangrene followed by amputation, and one died soon after operation

In résumé, we may say that out of forty-six purely cardiac cases, operated on between one to twenty-four hours, we have twenty-three (50 per cent) total cures, ten (21.7 per cent) developed gangrene, four of which survived and six died, two had partial circulatory restoration, and eleven died soon after operation. The total number of deaths was seventeen (37 per cent)

Of the twenty-six cases whose etiology was other than cardiac, operated on between one to twenty-four hours, eight (30.7 per cent) were cured; eleven (42 per cent) developed gangrene followed by amputation, of which four survived and seven died, two improved but died subsequently, and five died soon after operation. The total number of deaths was fourteen (53.8 per cent)

It may not be entirely fair to draw definite conclusions from these two groups of comparative end-results, since the number of cases of the first group (cardiac) almost doubles that of the second group, and also because it is difficult to make a definite distinction in some cases as to the predominating etiological factor, such as cases of thyrotoxicosis with advanced cardiac involvement, or advanced arteriosclerosis with definite heart lesions, *etc*

*Ultimate End-results*—In analyzing the ultimate operative end-results in this series, we find that out of 119 operated cases, forty-nine, or 41.1 per cent, were followed by complete immediate post-operative circulatory restoration. Thirty of these forty-nine cases which were followed up for a period varying between three months and one year showed the following results: six were alive and well three months after the operation, seven were living (presumably in good condition) four to six months after operation, and four were alive and well one year later. Thirteen of these patients died subsequently from secondary emboli, during a period varying between two days and eight months. In other words, thirteen, or 26.5 per cent, of successfully known operated cases, died soon after the operation from secondary

emboli It is only fair to assume that if the end-results were followed in the remaining nineteen cases, the same percentage of subsequent deaths would probably be obtained, which would give us a total number of eighteen, or 36·7 per cent, of subsequent deaths in those cases in which there was complete post-operative circulatory restoration This would reduce our percentage of ultimate operative recoveries from 40·8 per cent to 25·8 per cent

Of the thirteen cases in which there was only partial restoration of circulation, ten died shortly after the operation, either during their stay at the hospital or several weeks later, from secondary emboli, during a period varying between one day and four months after operation Of the three remaining cases, one died (cause not given) and two were alive and well one year later In both of these, the embolus was in the brachial artery

One may question whether some of these cases included in this group of partial circulatory restoration and some cases included in the group of complete circulatory restoration which died within forty-eight hours after operation, should be included in these two respective classifications, since insufficient time elapsed from the time of operation and death of the patient, to form a definite conclusion as to the degree of circulatory restoration But they are so classified by the respective surgeons and we have no other alternative but to include them as such in our classification

Of the nine cases not operated on, we find that in three there was partial restoration of circulation followed by subsequent death The partial circulatory restoration in these cases can be explained only on the basis of collateral circulation The other six cases developed gangrene requiring amputation, in four of these there was a fatal termination

*Collateral Circulation*—How much of the circulatory restoration is due to establishment of collateral circulation?

In a study of a little over 6,000 post-mortem examinations, Bull<sup>10</sup> found fifteen cases of arterial emboli supposed to have lodged in some of the largest vessels in the body—such as the aorta, common iliacs, femoral and axillary—days and even weeks before the death of the patient There was no history of gangrene prior to the patient's death in eight of these cases This is explained by the supposition that the embolus may not have been of sufficient size to cause complete circulatory obstruction in those vessels Collateral circulation may also have been established in some of the cases where the obstruction was complete

That the extent and intensity of circulatory disturbance is not always commensurate with the location and size of the embolus is illustrated by the case reported by Perman<sup>63</sup>

*Embolus at Aortic Bifurcation*—Female, aged thirty-seven, cardiac decompensation, aggravated by eight months' pregnancy Attempt to relieve obstruction by a bilateral arteriotomy in both femoral and iliac arteries Patient died three days after operation Autopsy showed obstructive thrombus, one and one-half inches long, at aortic bifurcation Gangrene of left leg and right foot He stresses the fact that there was some circulation of the lower extremities, almost to the knees, since the gangrene was limited to only that

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area and this could have been carried on only through some collateral circulation, after the embolus had lodged in the aorta

The extent of gangrenous changes in forty-two cases of obstruction of the lowermost portion of aorta by a thrombus or embolus, as observed by Hesse<sup>20</sup> in a post-mortem study of seventy-two cases, is as follows: no gangrene, seven, one foot or less, five, one leg (below knee), six, both legs (below knee), three, the whole of one extremity, eleven, both lower extremities right up the thigh, ten

Perman demonstrated by roentgenograms that "after double ligation and division of the femoral below the origin of the profunda femoralis, injection of lipiodol into the deep femoral entered the common femoral above the popliteal and its branches"

A Lemierre and R. Duruy<sup>30</sup> report a case of complete common iliac obstruction (proven by autopsy) occurring eight days before patient's death, without any visible circulatory disturbance. The circulation could not have been carried on through the collateral anastomosis of the branches of internal iliac. He believes that in this case the circulation was carried on between the terminal branches of internal mammary and the lumbar arteries on one hand, and on the other hand between the circumflex coming off the external iliac and subcutaneous branches coming off from the femoral. It is also probable that there was incomplete obstruction and subsequent canalization in the thrombus to permit a certain amount of blood to go through, which, in addition to the blood derived from the collateral branches, was sufficient to maintain the circulation of the limb. Circulatory restoration, in their opinion, may be in many instances due to the establishment of collateral circulation. "Where there was a complete breakdown of the circulatory apparatus, the restoration of circulation was very seldom attained, even if the operation was performed early (six to twelve hours)"

M. J. Fiolle<sup>30</sup> describes the extraction of an iliac embolus almost one month after the initial onset of pain. Two clots were extracted from the iliac artery through an incision made in the femoral. Blood did not flow freely and there was only faint arterial pulsation after the incision was closed, and even that disappeared completely at the end of the operation. In spite of that, there was only a small area of dry gangrene on the external surface of foot, several weeks after operation. The only logical conclusion in this case would be that a collateral circulation was established immediately after the onset of the obstruction.

Leriche<sup>40</sup> believes that most of the beneficial results obtained in the arterial embolectomies are due to the sympathectomy operation, which is practically done during the arteriotomy procedure.

Further proof that collateral branches play a most important part in the reestablishment of the circulation, particularly in the vessels of the upper extremity, may be adduced from a study of the end-results in ten cases of embolectomies performed on the vessels of the upper extremity. There was good circulation in all, but no brachial or radial pulsation could be felt, nor could any blood-pressure reading be obtained in the affected arm weeks and months after the operation, although the circulation was well maintained in all. The vessels affected in this group were one subclavian, two axillary, four brachials, and one radial. In two of these cases (brachial) no operation was done. In spite of that, the circulation was spontaneously restored.

*Prognosis*—The prognosis depends largely on the presence or absence of embolism in other organs, the artery involved, whether the embolism is unilateral or bilateral, the height and extent of arterial obstruction, the stage of cardiac involvement, the condition of the vessel wall, and, most important of all, the time elapsed between the onset of the disease and time of operation.

We must bear in mind that the embolus is only a link in a chain of serious multiple cardiovascular sequelæ, constantly threatening the health and life of the patient, and while the operative results are far from ideal, much suffering may be spared and many limbs and even lives may be saved, by prompt intervention and careful surgical technic. Better post-operative results can be obtained only by a wide dissemination among the general practitioners of the cumulative surgical experience gathered from a large group of cases, so that the practitioner may become thoroughly familiar with the various clinical aspects of this condition. Nothing can be gained from any other form of treatment. Procrastination inevitably results in gangrene—with all its associated sequelæ—sepsis, amputation, and, in many instances, death.

#### CONCLUSIONS

- (1) Early recognition and prompt surgical intervention give best results
- (2) The operation should be done under regional or spinal anæsthesia
- (3) Much better results are obtained in operations on the vessels of the upper extremity than those of the lower
- (4) Collateral circulation plays a very important part in the restoration of circulation, particularly in the vessels of the upper extremity
- (5) Secondary emboli, or coexisting emboli, at time of operation, contribute largely to the high mortality
- (6) Careful search should be made for other obstructive emboli or thrombi, above or below the primary embolus, before the incision in the artery is closed
- (7) Advanced arteriosclerotic changes do not necessarily contra-indicate the operation, but the prognosis is not favorable even when the operation is done early
- (8) It is doubtful whether the operation is indicated or justified in those patients who are suffering from a severe exacerbation of a subacute endocarditis, running a septic temperature, with a history of previous or associated embolic deposits. Very little may be gained from the operation in such cases<sup>28</sup>
- (9) Embolectomy is the only definite surgical therapeutic measure known to us at present for the relief of sudden circulatory obstruction by embolus

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# THE REDUCTION OF FRACTURE OF THE NECK OF THE FEMUR WITH CARL P JONES TRACTION SPLINT

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FRACTURE of the neck of the femur is difficult to treat because of the age group in which it occurs. Accurate reduction and a long period of time are required. The inability of many of the group to withstand the hardship of constant prolonged traction and suspension, or confining retentive plaster bandages, has defeated many fine reductions and well-conceived methods. In February, 1932, Carl P Jones<sup>1</sup> published a report describing

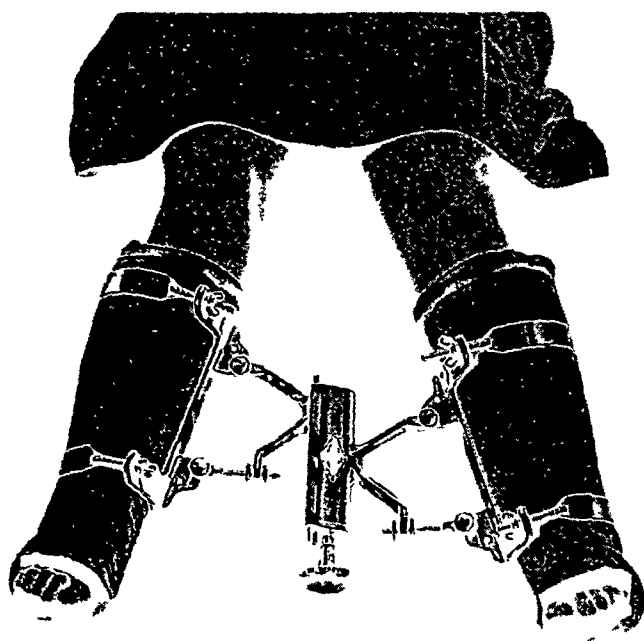


FIG 1—Jones splint applied (Courtesy of Martin Manufacturing Co., Ltd)

a special traction splint designed to secure accurate reduction, sufficient immobilization, and freedom from the confinement so injurious to these old people. The splint utilizes the principle of traction against the well leg.

We have used this splint in a series of cases and wish to make a preliminary report of the reductions obtained by its use. Insufficient time has elapsed to permit us to draw conclusions concerning final results.

The splint is attached to plaster-of-Paris bandages encasing both legs from below the knee. It consists of a traction barrel with two side arms for attachment to the bandages. The arm which is attached to the injured leg

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## FRACTURE OF NECK OF FEMUR

is movable on a screw and exerts the traction The arm which is attached to the sound leg is fixed and exerts the counter-traction (Fig 1)

The bandages are applied with extreme care to avoid pressure The leg is covered with a single layer of cotton wadding, four strips of one-quarter-inch thickness felt are cut in lengths to cover the lateral and medial surfaces of the leg, the instep, and the heel, and bound to the leg with gauze bandage (Fig 2) Four plaster-of-Paris bandages, six inches in width, are used to encase the leg from below the knee to the toes Internal rotation of the thigh is then obtained to a sufficient degree to return the great trochanter to its normal level The splint is then applied with both lower legs in internal



FIG 2—Preliminary protective dressing to legs (Courtesy of Martin Manufacturing Co., Ltd)

rotation This prevents flexion of the knee After the plaster has hardened traction is exerted until reduction has been effected This is determined by X-ray

The only anæsthesia we have used is one-quarter grain morphine There is some discomfort experienced when the thigh is being rotated, rarely any while traction is being applied

The advantages we have found in the use of the splint are

(1) Exact reduction is obtained with regularity and ease No anæsthesia is required and little discomfort is experienced by the patient Operating room or hospital equipment is not necessary

(2) Patients are comfortable immediately They may sit up or use a wheel chair a short time after reduction Nursing care is simpler and easier The danger of pressure sores and pulmonary complications is reduced to a minimum

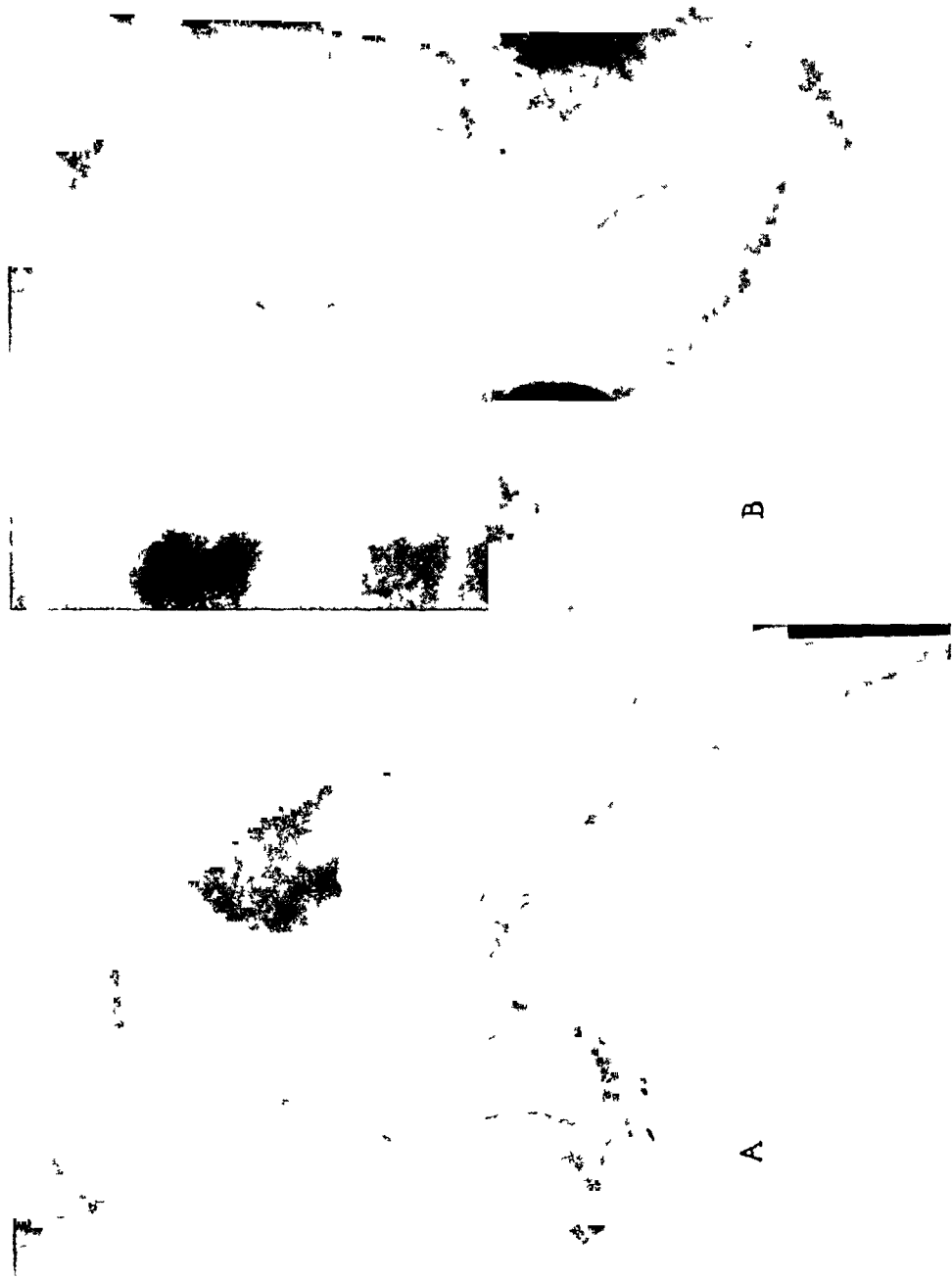
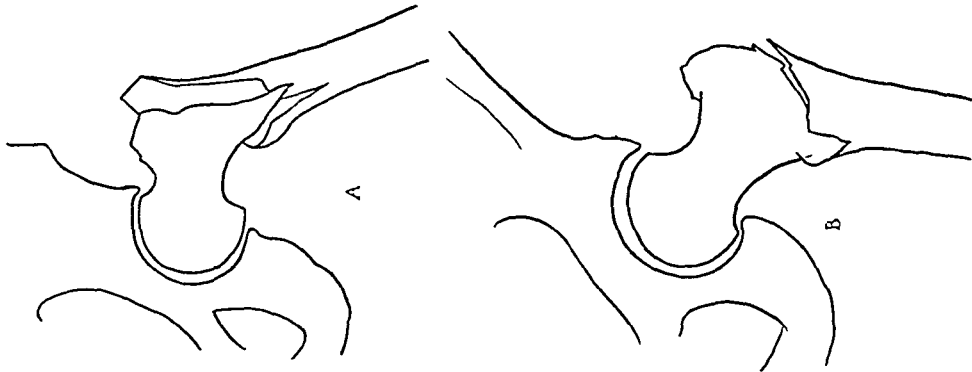
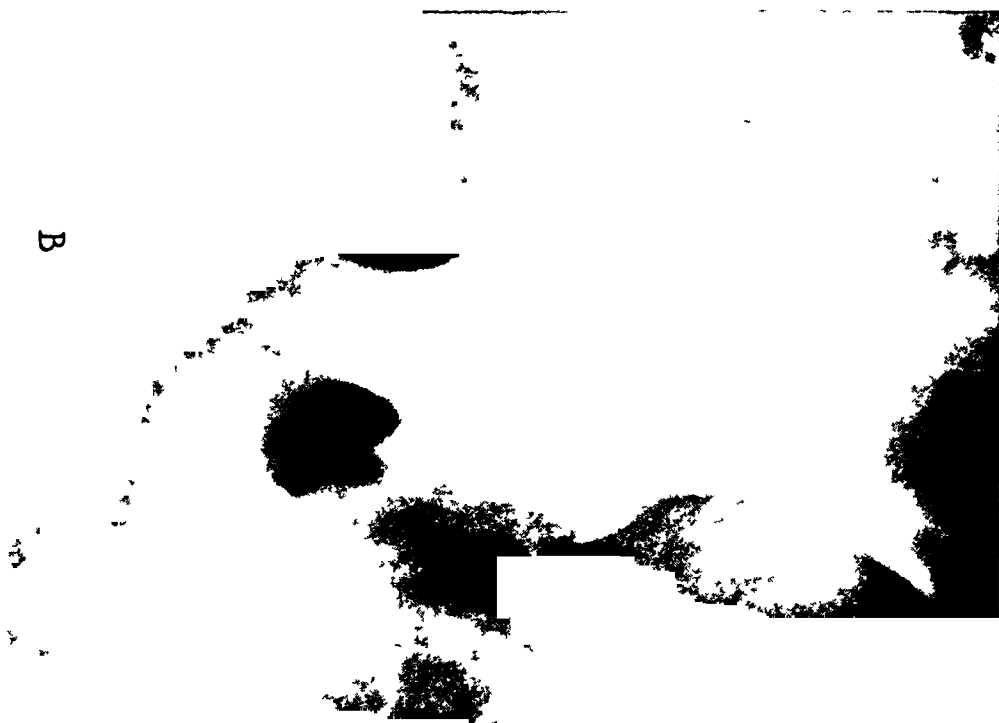


FIG 3 —(CASE II) Intertrochanteric fracture of the femur (A) Before reduction (B) After reduction



A



B

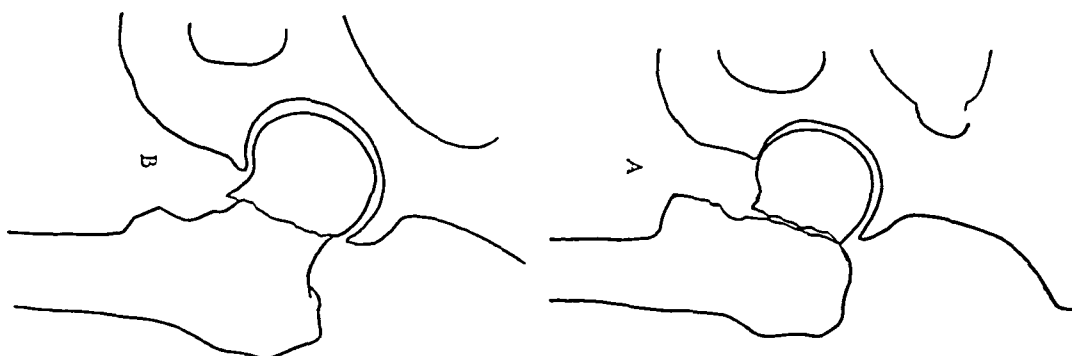


FIG 4—(Case III) Intracapsular fracture of the neck of the femur (A) Before reduction (B) After reduction

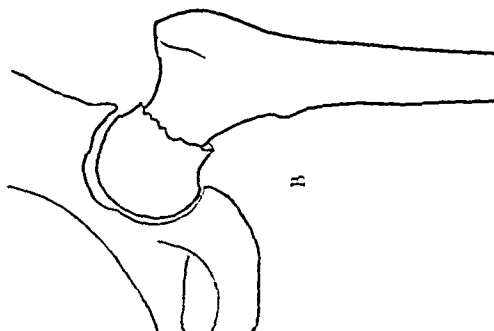
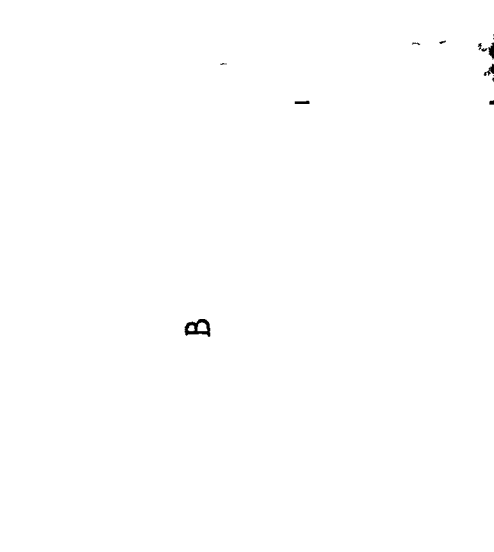
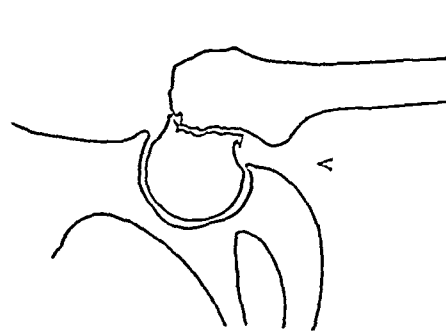
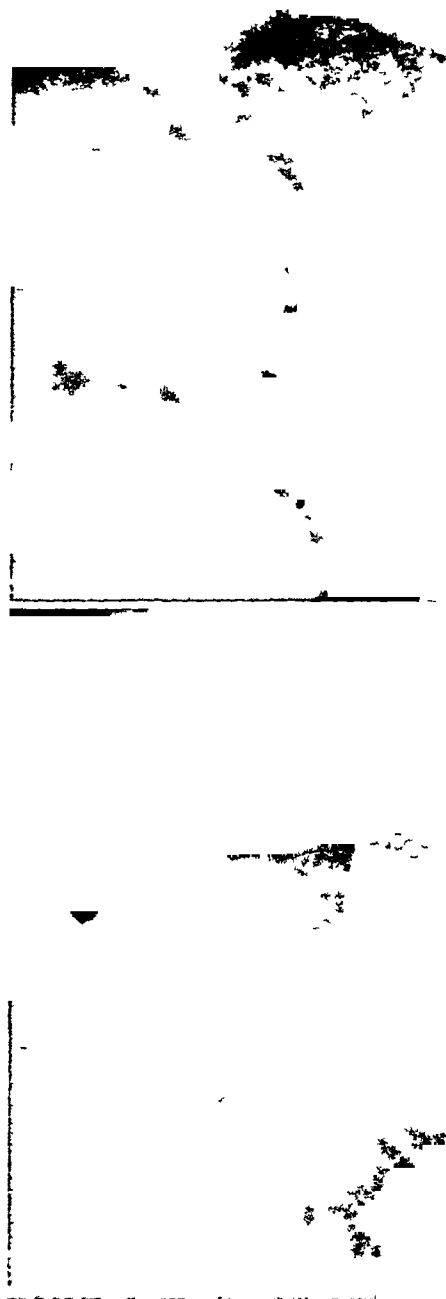


Fig. 5—(Case IV) Intracapsular fracture of the neck of the femur (A) Before reduction (B) After reduction

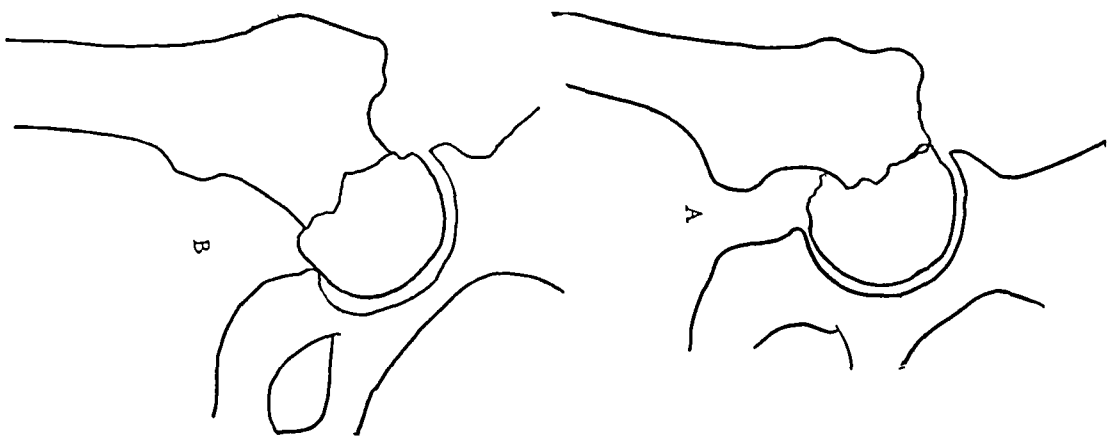


Fig 6—(Case VIII) Intracapsular fracture of the neck of the femur (A) Before reduction (B) After reduction

(3) All parts of the body except the lower legs and feet are exposed and accessible for physiotherapy

(4) Expense to the patient is greatly reduced by the elimination of operating room anæsthesia and prolonged hospitalization

In all we have treated ten cases with this method and every case was satisfactorily reduced X-rays before and after reduction in four of our cases are here reproduced

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 25, 1933

THE PRESIDENT, DR. JOHN DOUGLAS, IN THE CHAIR

MELANOMA OF FOOT WITH INGUINAL METASTASIS

WELL NINE YEARS

DR FRANK E ADAIR reported the case of a man, aged thirty-seven years, first seen about May 1, 1924, on account of a bulky mass in the right inguinal and femoral region. The past history was unimportant. His present illness began a few months before when he noted in the groin a hard tumor which continued to grow. There was no definite pain—only this feeling of fullness and pressure. He saw a physician who located a small mole on the dorsum of the right foot. The man remembered having injured the mole a few months before the mass was noted in the groin. The general physical examination was negative except for the presence of a small, elevated, black, ulcerating lesion one centimetre in diameter on the dorsum of the right foot situated about three centimetres posterior to the metatarsal-phalangeal joint of the third toe. The area of Scarpa's triangle as well as the inguinal region was occupied by a bulky mass which was composed of smaller, discrete, rubbery masses, so characteristic of melanoma. On account of the size of the groin mass, it was felt that the opportunity to effect a cure was meagre. As the metastasis had taken place by the lymphatic route rather than by the blood-stream, there was still an opportunity to cure the disease. Rectal examination revealed no enlarged palpable nodes along the course of the iliac vessels. The chest plate was negative. May 29, 1924, a radium pack of 10,000 millicurie hours was placed over the groin mass, and at that time a radium plaque of 1,260 millicurie hours was applied to the original lesion of the foot. On June 4, 1924, a generous excision was made of the foot lesion. Skin and subcutaneous tissues were removed down to the extensor tendons. Into this wound were placed four radon seeds. The skin was then undermined and the wound partially closed. At that time in the inguinal and femoral regions a very radical extirpation of the mass *with its overlying skin* was made. The nodes were closely adherent to the femoral vessels. A few nodes were removed from the femoral canal. The inguinal canal was opened but no nodes were found along the cord. Some radon seeds were placed along the femoral vein and artery in the femoral canal, beyond where one could reach by dissection, hoping to establish a barrier about the vessels against any extension of the disease by this route. Twelve seeds were thus scattered through the inguinal and femoral areas. The wound was closed with great difficulty—in fact, only by flexing the thigh on the body. It was nearly a year before the patient was able to fully extend the thigh. He leaned forward in walking during that period.

In this case it is felt that the amount of irradiation received before the operation is not nearly so much a factor concerned with the cure as the combination of radical surgery together with the interstitial implanting of



radium along the femoral vessels. Experience has shown that the amount of radium (10,000 millicurie hours) delivered by the pack effects very little change in the course of a melanoma. Much more irradiation is required to influence this tumor. One may see today under intense irradiation two types of changes taking place, one is the loss of the black pigment and the other is a diminution and rarely a complete disappearance of the lesion. The latter is extremely rare. There are 323 cases of melanoma in the Memorial Hospital since 1916. A study of melanoma made on his service two years ago revealed that of those treated by external irradiation (radium pack and X-rays) only 25 per cent responded by improvement. He, therefore, yet considers melanoma a disease to be treated principally by surgery, although interstitial radon and *intense* external irradiation are suggestive of being of value in treating this highly malignant disease. Of the sixty-four cases actively coming to the clinic, twenty-four have been under treatment three years or more. There are one ten-year case, three nine-year cases, two seven-year cases, two six-year cases, four five-year cases, four four-year cases, and eight three-year cases. Twelve, or 18 per cent of these are living five years or more. Of the total group of 323 cases there are twenty-seven cases (83 per cent) who lived over five years. But as they have had many more fresh untreated cases during the past two or three years, his impression is that they will run a higher percentage of cures than 83 per cent. There were twenty-five cases admitted to the service during 1932.

The disease is not so hopeless as is generally believed. Dissemination occurs by neglect on the part of the patient as well as ill-advised methods of treating the original lesion by barbers, chiropodists, physicians, and occasionally surgeons. Having once taken on the quality of growth it is a delicate problem to work out the best type of therapy. Fully half the cases that come to his clinic come with recurrent local or metastatic disease, and, as a rule, this half are usually dead within one or two years. Dissemination is by two routes—first the blood-stream route, in which instance you rarely ever get a cure, secondly, the lymphatic route, where *all* the cures of this disease occur after dissemination has taken place.

The way to cure melanoma is by careful local removal before the time when the black mole has taken on rapid growth—in other words, prophylactic cancer surgery.

## THE SLOW COURSE OF A CANCER OF THE BREAST IN AN ELDERLY PERSON

COVERING A THIRTEEN-YEAR PERIOD

Doctor Adair presented a woman, sixty-four years of age, who came to Memorial Hospital June 14, 1922. At that time she stated that she had noticed a flattening and an elevation of the right breast for a period of two years. During this time the nipple had retracted. She was a woman whose tissues appeared older than her years. There was marked arthritis deformans, the hands showing ulnar deflection on the wrists. The right breast was elevated and shrunken, its nipple was retracted. (Figure 1.) Just beneath the nipple was a small area of induration not over one centimetre in diameter. This small tumor was very hard. There were no enlarged axillary or supraclavicular nodes. The chest plate revealed evidence of an old tubercular infection which was healed. At the time that she came Doctor Adair made the following note: "This is the type of case in which I think we will get a good result either with surgery or X-ray because she has a very slow metabolic rate as evidenced by the type of her tissue and by the premature ageing." She received during 1922 one low-voltage X-ray treat-

## CANCER OF THE BREAST IN THE AGED

ment During 1923 she received two very mild X-ray treatments In September, 1929, she received one high-voltage treatment over the breast and in July, 1932, she received her last X-ray treatment No one of these treatments was of sufficient strength to very perceptibly change the course of the disease The strongest X-ray treatment which she received was the one in 1932 which was not of sufficient strength to cause an erythema, it being only 600-r units The mild treatments which she received may have influenced the disease very slightly, but by experience they know that the amount received influences cancer only to a minimal degree He therefore presented this case as one in which the normal body resistance against the invasion of a low grade carcinoma has been observed over a period of eleven years but the duration of which disease has been known to the patient



FIG 1—Appearance of the breast of woman when she first came to the hospital in 1922

for at least thirteen years During the course of the years the breast became more atrophic, more elevated and eventually completely disappeared, so that in June, 1929 (Fig 2) the appearance of the right chest-wall was that of a person who had had a mastectomy performed, following which a skin graft had been done There was a complete absence of the pectoral muscle at this area, one could palpate the ribs, which seemed to lie immediately beneath the skin In the centre of this area was the tiny nipple At that time there was one small tender node in the right axilla but it was not definitely carcinomatous The chest plate and the supraclavicular region were still negative A few months later there were two or three small nodules situated at the periphery of this area One was removed, the pathological report stated "breast carcinoma, rather inactive—in scar tissue Fibrocarcinoma" This condition apparently progressed slowly She was away from the city and was not seen again until 1932—nearly two years—at

which time we found that there had been some increase in the size and the number of the peripheral nodules (Fig 3) The disease, however, was still limited to the chest-wall The X-ray plate of the chest on March 28, 1932 revealed no evidence of metastasis At the present time she is in about the same general condition and, as far as we can tell, has a very small amount of carcinoma present, which process seems to be localized in its original area on the chest-wall

The remarkable course that this case has taken could be explained on two grounds In the first place, it is a very low grade type of fibro-carcinoma The carcinoma cells are few in number and are imprisoned in the dense fibrous tissue which permits of little opportunity for infiltration and dissemination In the second place, the patient has such a low metabolic rate and the cells in general have such a poor opportunity for nourishment that the tumor bed is not as conducive to rapid growth as most carcinomas



FIG 2

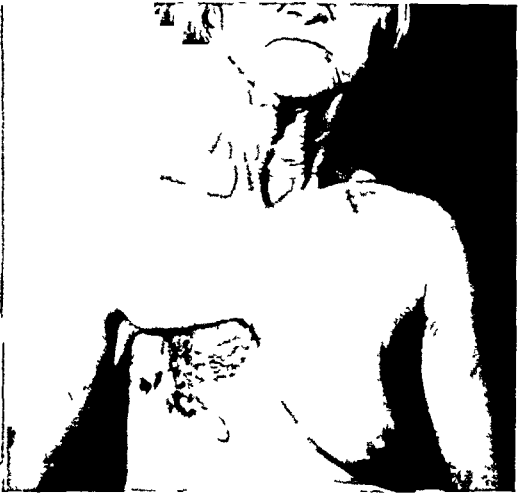


FIG 3

FIG 2—Appearance of the chest wall after there had been complete spontaneous atrophy of the right breast The tiny nipple shows in the center of the area (June, 1929)

FIG 3—Appearance of the lesion March 28 1932 The area is much the same as in Fig 2 except that there has been some nodulation and growth in the skin below the original breast There is no evidence of the disease in the axilla, supraclavicular or chest The process is confined entirely to the chest wall

DR JOHN DOUGLAS referred to a case shown before this Society by the late Doctor Kammerer about fourteen or more years ago The patient was an old woman with an atrophic scirrhous carcinoma of the breast The tumor had been present for thirteen years and was no larger than two to three centimetres in diameter This was before X-ray therapy had been perfected and the discussion was whether or not to operate on that breast There are cases where not only is the patient elderly but one finds a type of growth which increases slowly in size and in which there is little or no tendency to metastasis

#### LYMPHŒDEMA OF THE ARM

DOCTOR ADAIR presented a woman, forty-nine years of age, who first came to the Memorial Hospital May 27, 1929 Five years previously she had a radical mastectomy performed in the Panama Canal Zone for a carcinoma The pathological report which she brought was "fibro-adenocarcinoma" Following the operation, she received some X-ray treatments

## LYMPHŒDEMA OF THE ARM

When admitted to the Memorial Hospital, however, the skin over this area revealed no evidence of intense treatment. Examination showed a fullness near the scar but it was thought that no definite recurrence was present. There was no axillary or supraclavicular disease. The liver was not enlarged. X-ray plate of the chest revealed no metastasis. Her right arm and hand were greatly enlarged. One year previously it had been similarly enlarged. The forearm and hand had many pustules present. Between the fingers were excoriated, red elongated areas, and some of the interphalangeal spaces were split. It was the typical appearance of multiple infections and lymphangitis, that so frequently accompany elephantiasis. When she accidentally pricked her hand or arm with a pin, it would drain serum for three or four days before the prick wound would heal. Periodically she experienced chills and fever as a result of the infection of the arm and hand. Frequently the red streaks of lymphangitis were present. The arm was heavy at all times, but especially heavy and painful during these attacks.

In April, 1930, right supraclavicular nodes appeared. These were treated by a radium pack of 16,000 millicurie hours. The nodes had disappeared by July, 1930.

October 17, 1930, on account of the recurring attacks of dermatitis and lymphangitis, it was decided to do a modified Kondoleon operation on the forearm. This operation was chosen because experience in doing Handley's lymphangioplasty had met with little encouraging results, as was also true of the classical Kondoleon or the Sistrunk modification of it. An incision was made on the volar surface of the forearm extending from the wrist to the cubitus. The subcutaneous tissues were widely undermined and dissected down to the deep fascia, including a good-sized width of the latter. The fascia was tense, bulging and very thick, as is so characteristic of the deep fascia in these cases. The subcutaneous tissues were much thickened and rather dense. The muscles were separated by blunt finger dissection down to the bones and interosseous space of the forearm, in an attempt to establish communication between the superficial and deep lymphatic channels. Another incision was made on the inner aspect of the upper arm extending from the cubitus to the posterior axillary fold. Here also the subcutaneous tissues and deep fascia were widely excised. Blunt dissection was employed to the depths of the humerus. An incision was made under the posterior axillary fold and through this the finger was swept over the right scapula posteriorly in order to drain the arm in the post-scapula route to the interscapular area and across to the opposite side. The wounds were closed with continuous silk. The hand, forearm and arm were tightly bound from below upward by gauze and muslin rolls. The arm was then suspended. There was a striking diminution in the size of the hand and forearm. The arm was similarly bandaged for a period of a month, in an attempt to drive the superficial lymph downward into the lymph spaces along the deeper veins and about the bones. Along the larger veins are found the larger calibred lymph vessels. There was immediate improvement both as to relief of pain and as to infections. The excoriated areas between the fingers disappeared. She was able to use smaller gloves and smaller dress sleeves. The movements of the hand were more free. The chills and fever disappeared.

Since this time the condition has been stationary. While this is not an ideal result as the hand and arm are still enlarged, it is, however, a much improved result over the original not only as to size but also as to infections.

Lymphœdema and elephantiasis are the despair of surgery. In spite of enthusiastic reports from certain sources concerning lymphangioplasty and

the Kondoleon operation, it had not been the reporter's experience to obtain such results or to observe them in the hands of other operators. One should not hesitate to try more than one type of operation in the same patient, before resorting to an amputation. In his experience the commonest types of lymphœdema of the arm in order of frequency encountered are

(1) Following radical amputation of the breast where there has been an axillary infection, or post-operative accumulation of serum at the arm end of the incision, resulting in excess scar tissue. (2) Blockage of the axillary lymphatics by bulky metastatic disease. (3) Excess fibrosis of the axilla due not to infection but to a large axillary space covered with skin stretched tightly over it like a drum head. This situation always creates an excess amount of fibrous tissue blocking the lymphatics and choking the axillary vein. (4) Excess amount of tissue fibrosis secondary to ill-advised irradiation. (5) Idiopathic—one occasionally sees lymphœdema develop without any ascertainable reason. (6) Filariasis. (7) Congenital.

DR BRADLEY L. COLEY said that he thought lymphœdema after radical breast amputation was due to several factors. The removal of all the lymphatics was but one factor, pre-operative and post-operative irradiation another, and infection probably the most important of all. When a combination of all these three factors existed, a lymphœdema, in his experience, has been most pronounced and most persistent. As far as operations for relief of lymphœdema are concerned, he felt that none thus far devised were productive of very satisfactory results. The speaker asked Doctor Adair if he felt that lymphœdema was more prone to occur in those cases that have had pre-operative or post-operative irradiation in conjunction with radical mastectomy.

DR HENRY H. M. LYLE believed that infection and recurrence of the disease caused the worst types of œdema. He asked Doctor Adair's opinion whether post-operative X-ray treatment increased the number of cases of œdema. Doctor Lyle said it was his practice to radiate all cases after operation but he has found that such cases develop œdema more often and of a severer grade than those that are not rayed. There is often a transitory œdema which comes on shortly after the operation and then subsides. Then there is another type which comes on late after the radiation, it may develop along with X-ray changes in skin, two, three or four years after. This fact has not been emphasized enough. The type of the incision has some bearing. He has noticed in the cases where the scar has been carried too far down on the arm that they had an excessive amount of œdema. It is his impression that in suitable cases a well-planned transverse incision gives less œdema.

DR WILLIAM CRAWFORD WHITE said that he had often been puzzled to determine the cause of the œdema in the arm. Every case has œdema, whether recognized by casual inspection or not, on the side operated upon.

## ANGIOSARCOMA OF THE CHEST-WALL

He agreed with Doctor Adair that infection is the most important factor in lymphœdema. There is an œdema of the arm and forearm that often appears, only to disappear in a few months after the operation. In reference to the matter of the incision Doctor White agreed with Doctor Lyle that there is less chance of scar tissue in the upper apex of the axilla through the transverse incision. This is preferable and is less likely to cause œdema.

Doctor Adair, in closing the discussion, said that a few more cases of lymphœdema of the arm are seen now than before the days of the introduction of heavy irradiation therapy. The commonest cause of lymphœdema, however, is undoubtedly infections of the axilla. Any agent such as infection or irradiation which produces an extra amount of scar tissue will bring about the blocking of the lymphatics. Lymphœdema is probably more frequently caused by blockage of the larger sized lymphatic channels, which course in close proximity to the big axillary veins, rather than by the blockage of the small-sized lymphatics and lymph-nodes or their removal such as one does during the routine axillary dissection.

## ANGIOSARCOMA OF THE CHEST-WALL

DOCTOR ADAIR presented a woman, aged forty years, who came to the Memorial Hospital December 5, 1925. She stated that six years previously she noted pain in the left posterior chest-wall. About one year later, a hard lump appeared at this site. The lump increased in size, while the pain had been intermittent. Three weeks before coming to the Hospital the pain became severe and had persisted since. At times pain was present in the left shoulder and radiated down the left arm. Her general condition was good. A double aortic murmur was heard at the apex of the heart. Abdominal examination negative. Situated in the lower chest-wall posteriorly was a large, ovoid, firm mass fixed to the chest-wall. It measured approximately fourteen by fourteen by eight centimetres. The bulky mass extended from the spine to the posterior axillary line (Fig 4). The mass pulsated. X-ray examination revealed no bone tumor and no metastasis to the lungs. A clinical diagnosis of angiosarcoma was made because of its pulsation, its doughy consistence, its fixity, and its recent rapid growth. During December, 1925, and January, 1926, the tumor received three high-voltage X-ray treatments. February 13, 1926, an attempt at surgical extirpation was made. The tumor lay on and between the sixth to the tenth rib. It was situated beneath the lower portion of the trapezius and the upper fibres of the latissimus dorsi muscles. It was an easy matter to expose the tumor which was encapsulated. The attempt at extirpation was met with terrific hæmorrhage typical of this type of sarcoma. Due to the extent of the tumor and the fact that they could approach its blood supply only from its "surface" (unless by opening the chest-wall) it was decided to abandon any further attempt at removal. The wound was drained and closed up. Six weeks later, March 29, 1926, twenty-five radon seeds (5,344 millicurie hours) were inserted into the tumor under a general anæsthetic—being applied directly through the integument. During March, 1926 three more high-voltage X-ray treatments were given over the tumor. By April 20 of that year, the bulk of the tumor had diminished one-half; however, there was a new development laterally. Into this were inserted thirteen radon tubes (2,554 millicurie hours). The continuous pain disappeared as the tumor diminished. Further irradiation was

applied by radium packs. In October, 1926, a new mass appeared about the level of the fourth and fifth ribs above the original site. Into this mass were inserted ten radon tubes (4,978 millicurie hours). This mass disappeared. During the next two years three high-voltage X-ray treatments were given over the local extensions of the original tumor. The tumor, following this, entirely disappeared, the area about it became markedly fibrosed. There has never been any recurrence of pain, and no local or distant metastasis.

It is unfortunate that hæmorrhage prevented them from obtaining a section for microscopical study. After consultation with Ewing it was felt that they were justified in reporting this as a case of angiosarcoma not only on



FIG. 4.—Showing a bulky tumor of the left chest wall, extending from the spine to the posterior axillary line. The tumor was treated by implanting seeds of radon into the tumor. Later radium packs and high voltage X-rays were given. The patient is well and free of disease for a period of seven years.

clinical grounds, but more especially by the post-operative clinical course, and the rather characteristic response of this tumor to interstitial and external irradiation. At any rate, a tumor which kept recurring locally over a period of two years, and which was originally inoperable, was brought under control by this method of therapy. The patient is well and free of disease for a period of seven years.

Dr BRADLEY L. COLEY said that without question angiosarcoma belongs among the tumors which must be classed as radio-sensitive. He recalled two cases of bulky, vascular tumors, one of which was a patient with involvement of the entire hand, forearm and upper arm which he had seen with Doctor Bancroft, the other was a little girl with massive involvement of

## STAB-WOUNDS OF THE CHEST INVOLVING THE DIAPHRAGM

the lower extremity, chiefly below the knee. Amputations were done in both of these cases and the report in each instance was cavernous angioma of muscle. One of these cases is still alive over a period of seven years. These bulky angiomas may best be treated by steady, mild irradiation, given chiefly by means of high-voltage X-ray rather than radium interstitially, although the latter may be a useful procedure in certain bulky, deeply placed areas. The speaker wondered whether the case reported by Doctor Adair might not be an example of this type of cavernous angioma of muscle.

## STAB-WOUNDS OF THE CHEST INVOLVING THE DIAPHRAGM

Dr. JOHN F. CONNORS presented two men.

**First Case.** M. O., bullet wound. Bullet entered the chest, penetrated diaphragm, produced two lacerations of the stomach, and lodged in the posterior chest-wall. Operation—Chest entered, diaphragmatic laceration sutured and the diaphragm sutured to chest-wall, obliterating costophrenic sinus. Left hospital to go to reformatory, returns with small sinus at the bottom of which necrotic bone may be felt. His X-ray shows an obliteration of the costophrenic sinus, no indication of hernia of diaphragm.

**Second Case.** R. W., stab wound. Stabbed three times in chest, each wound penetrated the diaphragm. Patient's condition was very poor. The two lacerations of the diaphragm each about an inch in diameter and one a half inch in diameter. The two larger lacerations were sutured and the small one was obliterated by suturing the diaphragm to the chest-wall, thus obliterating costophrenic sinus. Abdominal exploration not attempted because patient was in extremis. Perfect recovery.

The reporter added that the subject of penetrating wounds of the diaphragm was brought to his attention by an unusual case which had been briefly mentioned in another communication.

C. G., male, aged twenty-six, was admitted to the Harlem Hospital, June 26, 1931, and died two days later. He had been stabbed by an assailant wielding a kitchen knife. There was a sucking wound, one and one-half inches long, situated about one inch above and one inch mesial to the left nipple. The roentgenogram of the chest showed a slight pneumothorax, a high diaphragm, and a very slight amount of fluid in the left chest. His condition was good, but operation was performed by an assistant for the purpose of closing the sucking wound of the chest. A five-inch diagonal incision was made with the wound of penetration at its middle and the pectoralis major bluntly divided in the direction of its muscle fibres. The fourth costal cartilage was found completely severed, together with the pleura attached to it. The lung, which was but little collapsed, came well up to the chest-wall with respiration. Neither the lung nor the pericardium which readily could be seen was injured. The diaphragm was not in view and it was not sought because it did not occur to any one that harm could come to it through a wound so high on the chest-wall. The intercostal vessels were ligated. The wound in the pleura was closed by suturing over it the severed intercostal muscles and the pectoral major muscle. Drainage was introduced just through the skin.

The post-operative course was uneventful the first day, but on the second day with unusual rapidity his respirations and pulse increased, he became



stuporous and died. A roentgenogram of his chest taken about two hours before death showed a diffuse shadow, apparently of fluid, in his left chest.

At the post-mortem examination there was found a wound in the anterior portion of the dome of the diaphragm about one and one-half inches in length and through it the fundus of the stomach protruded, bulging into the pleural cavity for a distance of about three inches. This portion of the stomach was necrotic and had perforated. In the pleural cavity there were about 750 cubic centimetres of thick brownish-red fluid containing blood and necrotic stomach wall. The pleura was covered with a little fibrinous exudate.

The striking facts in this case were that a knife entering the chest-wall as high as the fourth rib, causing only a small wound of entrance, could produce a wound of the diaphragm, and that an abdominal viscus could protrude through this wound, become constricted, perforate, and soon cause death.

After this death the diaphragm was carefully examined in all cases in which operation was performed. In sixty-four consecutive cases of thoracotomy in penetrating wounds of the chest which have been reported, penetration of the diaphragm was found in eleven cases, an incidence of 17.2 per cent. These observations are based upon these eleven and two additional cases. Two of these thirteen cases were bullet wounds and eleven were stab wounds.

*Site of Penetration upon the Chest-wall*—Penetration of the diaphragm has been associated with chest wounds at various points below the fourth rib. It must be borne in mind that in the excitement of struggle, there will be forced respirations and the diaphragm may rise to a high level. Therefore, in any chest wound below the fourth rib we should be suspicious of penetration of the diaphragm.

*The Diaphragmatic Wounds*—The size of the wound in the diaphragm varied from one-half to one and one-half inches. The majority were one inch in length. They were situated most often in the portion of the diaphragm at the costophrenic angle.

Omentum was recorded as protruding through the wound in the diaphragm in two-thirds of the cases. It is interesting that this "policeman of the peritoneal cavity" should extend his duties into the chest cavity when the occasion arises. Probably in this way in unoperated cases a great many diaphragmatic penetrations of small size have been entirely healed. It might be possible to repair the diaphragm by fixing the omentum with sutures in the laceration, but they have not tried it.

*Associated Abdominal Injuries*—The spleen was injured twice, once by a knife and once by a bullet. The knife produced a half-inch laceration which was sutured. The bullet caused a rupture of the spleen necessitating splenectomy. In one instance there were two bullet holes in the stomach, which were sutured. In another case a mesenteric vessel was severed causing a small amount of hæmorrhage. Finally, in one case, there was an injury to the pancreas. It was not discovered at operation but at post-mortem, which showed hæmorrhage and fat necrosis. In this case the abdomen was explored through the hole in the diaphragm which was extended. (McGowan's case since.)

*Exploration of the Abdomen*—In cases of bullet wounds a separate exploratory abdominal incision unquestionably should be made. In the cases of stab wound it was not really necessary except in the instance in which the pancreas was injured. In six patients the abdomen was explored by enlarging the hole in the diaphragm. Included in these was a case of pan-

## THE HEALING OF SURFACE WOUNDS

creatic injury They were impressed with the fact that no hollow, movable viscus was injured by a knife, whereas the fixed solid spleen and pancreas were penetrated This experience corresponds with that in diagnostic abdominal puncture in which a movable hollow viscus is safe from the needle point We feel, however, that because of possible injury to a fixed viscus requiring repair, a separate abdominal exploratory incision should be made The other possibility of stomach or intestine protruding through a hole in the diaphragm and becoming strangulated must also be borne in mind

On the right side, exploration is not necessary since the liver acts as an effectual barrier to injury to other abdominal organs and at the same time does not allow protrusion of a viscus into the pleural cavity

There were four deaths in cases of penetration of the diaphragm Only one was directly due to an injury of an intra-abdominal viscus, *i e*, the case of the lacerated pancreas One was indirectly due to the lacerated diaphragm when the stomach came through and became necrotic Of the other two cases, one died five days after operation Post-mortem examination showed pneumonia of the right lung and a completely collapsed left lung The other patient died nine hours after operation, apparently of shock Post-mortem examination revealed a markedly hypertrophied heart of the bovine type

### THE HEALING OF SURFACE WOUNDS FOR THE PREVENTION OF DEFORMITIES

DR FENWICK BECKMAN read a paper with the above title, written by himself and Dr RICHARD O'CONNELL, JR (by invitation), for which see page 394

DR KIRBY DWIGHT said that surgeons still have something to learn about the treatment of burns, avulsions and other injuries involving the skin He has heard time and again the question asked whether skin grafting would be necessary That question presupposes the idea in the physician's mind that skin grafting is a last resort to be used only when nature will not close a defect in the skin It shows lack of appreciation of the end-result in these injuries if left untreated by skin graft Its main purpose is to prevent excessive amount of scar tissue forming at the base of the injury

DR HENRY H M LYLE said that the fate of the patient who sustains a severe trauma or burns of the soft parts often lies in the hands of the first man who sees them In accepting the responsibility the physician must have a clear conception of what the future may call for Immediate treatment must be undertaken to prevent infection and forestall functional loss by guarding against contractures and deformities Prompt healing is an essential requirement in obtaining early functional use and much time is saved and much better functional recovery is obtained by the early use of suitable skin plastics

The following methods are used in treating the above conditions

(1) The wound can be allowed to heal by granulation If large areas are involved, this is a wasteful and often a disastrous method Unfortunately, it is the commonest, it is mentioned only to condemn it

(2) Immediate debridement and suture can be applied in a small proportion of cases. There must exist ideal conditions and control of the patient to be successful.

(3) Primary skin plastic by graft or sliding flap. This method can be employed only in a small number of cases.

(4) Prompt sterilization of the wound and application of some skin plastic. This method is of wide application.

(5) The use of the principle of skin plastics in series. The temporary application of Thiersch grafts to the sterilized area with the object of obtaining a covering of skin. When all danger of infection has passed and the time is ripe for further reconstructive work the Thiersch grafts are removed and full-thickness grafts, sliding flaps or pedicle grafts are substituted. A suitable skin covering for future reparative work such as tendon grafting, resection of the joint, *etc.*, is obtained.

DR CARL G BURDICK said that in deciding what type of graft to use in children, one is limited by the amount of skin that can be obtained from the individual. In the Thiersch grafts more surface is used than in pinch grafts so the latter are superior in children. Doctor Beekman's attention to details cannot be too strongly emphasized. The principles in grafting are to obtain uniform pressure plus immobilization. Many failures are due to lack of attention to these details. The speaker had a case recently of a man who had complete avulsion of the skin of the os calcis and by using pinch grafts a perfectly good weight-bearing result was obtained. Pinch grafts closely applied give the same result as a full-thickness graft.

DR FREDERIC W BANCROFT agreed with Dr Beekman on stressing the necessity of excising the scar tissue lying beneath the granulation tissue in burn cases. He reported the follow-up on a case that he had exhibited before the Surgical Section years ago. This was a child who had had extensive burns from the hips to the ankles of both legs. Attempts at pinch grafts, where the superficial granulation tissue had been curetted off, were failures. He had then found that if the scar tissue were excised by sharp dissection down to the aponeurosis and immediately pinch grafts applied success resulted. This principle has not been properly emphasized in the treatment of old granulating wounds. In the case reported there were marked contractures at the knee-joint. After epithelialization had been completed the contractures were cured by application of a splint which had a door spring attached to it. This gave a constant elastic pressure tending towards extension. The child was taken to the operating room a number of times, given an anæsthetic, the knee-joints stretched and the scar tissue cut in the popliteal space. This area was immediately grafted. By these repeated small operative procedures it was possible fortunately to get complete extension.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD FEBRUARY 24, 1933

The President, DR JOHN DOUGLAS, in the Chair

### BACTERIAL SYNERGISTIC GANGRENE OF THE ABDOMINAL WALL

DR FRANK L MELENEY presented four patients illustrating progressive bacterial synergistic gangrene of the abdominal wall. The first case was included in the paper on bacterial synergism presented to this society in May, 1931.<sup>1</sup> The patient was not shown at that time because he was still in the hospital. He is brought here this evening simply to compare his case with the three others that had been seen since that time.

CASE I—Patient of Dr Richmond Moore's in the Presbyterian Hospital in December, 1930. He was operated on for an appendix abscess of two weeks' duration. A right rectus incision was partially closed by two silkworm-gut sutures above, with a drain below. On the third day there were signs of infection of the wound. On the thirteenth day the upper silkworm-gut suture holes took on a carbuncular appearance with gangrene at the centre which gradually spread outward. On two occasions slough was cut away, but the lesion continued to spread. On the twenty-seventh day it was recognized as being similar to the case which Doctor Brewer reported in 1926. Wide excision was advised and carried out. There was no recurrence of the infection. The wound promptly granulated and was soon covered with grafts.

CASE II—Private patient of Dr F B St John's in Presbyterian Hospital in March, 1932. He had a carcinoma of the sigmoid and a preliminary cecostomy was done. The wound was partially closed with silkworm-gut sutures. On the eighth day there were signs of wound infection and this went on to frank gangrene of the upper wound margins and the wound ends. The gangrene continued to spread. During this time attention was diverted from the wound by a coronary episode which was almost fatal. Later it was recognized as being similar to the other cases of progressive bacterial synergistic gangrene of the abdominal wall. It was widely excised. The disease did not recur. The wound promptly granulated and was later covered with skin grafts.

CASE III—Private patient of Dr Roswell Schmitt at the Horton Memorial Hospital in Middletown, N Y, in August, 1931. She had an appendix abscess which was drained, and the wound partly closed by sutures. On the fifth day the wound showed evidence of infection. Within a few days the upper wound margins became bluish and then frankly gangrenous. The gangrene slowly spread in spite of all efforts to halt its progress. By the seventieth day it involved practically all of the lower half of the abdomen and part of the upper right side. It was widely excised and did not recur. The wound promptly granulated over and later it was covered with skin grafts.

CASE IV—Private patient of Dr John Carlisle at the Passaic General Hospital in Passaic, N J, in October, 1932. Following a perforated duodenal ulcer he developed a subphrenic abscess which was drained. The

wound was partly closed with retention sutures. On the fifth day the wound showed signs of inflammation. On the eighth day there was considerable necrosis of the wound margins especially in the region of the retention sutures. The necrotic tissue was cut away but the infection continued to spread. On the fourteenth day he was seen by the reporter who confirmed the diagnosis of progressive bacterial synergistic gangrene. Wide excision was done, the wound promptly granulated and on the sixth day it was covered with pinch grafts.

**SUMMARY**—The disease is a definite clinical entity which has a characteristic course. It appears in wounds through which an approach has been made to a peritoneal or pleural abscess. Infection of the wound is evident from the third to the tenth day. It becomes excruciatingly painful, then slowly the wound margins or retention suture holes take on a raised, swollen, purple appearance which goes on to frank gangrene. Outside of the zone of gangrene is a raised purple zone and beyond that a brilliant red zone. The disease spreads locally in spite of all forms of conservative treatment and the only satisfactory method of treatment that we now know is wide excision.

#### PSEUDOMYXOMA PERITONEI

DOCTOR MELENEY presented a man of forty-five who was admitted to the Presbyterian Hospital May 15, 1933, with a history of lower abdominal pain with occasional chills and fever and a loss of thirty pounds in five months. He had a tender mass below the umbilicus to the left of the mid-line which seemed to be about eight to ten centimetres in diameter. The barium enema showed the sigmoid passing around the tumor and no diverticula were seen. The rest of the colon appeared to be normal. He was operated upon and the free peritoneal cavity was opened. The mass was found to be fixed to the retroperitoneal tissues and to have about it many fibrous adhesions. The mesentery of the ileum and a portion of the ileum itself were firmly adherent to the upper surface of the mass and the sigmoid and mesosigmoid to the lower surface with an interval of about two centimetres between the two loops of gut. The incision did not permit extensive exploration and with the idea that it was an abscess which should not be opened at the primary operation for fear of flooding the free peritoneal cavity with pus, the anterior abdominal wall was sutured to the mass in the interval between the ileum and sigmoid. A week later the mass was punctured with a needle and syringe and about two cubic centimetres of pus were obtained. When the needle was inserted in a slightly different direction in an effort to find a larger cavity, mucous material and some bits of tissue were obtained. In another direction a second small abscess was found and a single tube inserted into it.

A culture of the pus revealed several different organisms almost certainly of intestinal origin and the bits of tissue which were sent to the Surgical Pathology Laboratory were reported to show well-differentiated intestinal glands. The pathologist could not decide whether the specimen was a bit of mucous membrane or whether it represented a pseudomyxoma or an enterocystoma. Subsequently a considerable amount of pus was discharged from the mass and it gradually reduced in size. However, in the course of the next week, it was evident that fecal material was being discharged from the mass. This, however, gradually ceased and he left the

hospital somewhat better. During the summer he continued to improve. On several occasions the wound opened and discharged foul-smelling pus and once there was a discharge of pus into the rectum appearing later in the stool. He returned to his occupation of teaching when school opened in the fall. During this time the tumor steadily decreased in size, and his weight returned to normal. In December, however, about six months after leaving the hospital, the wound opened and a fecal fistula developed which continued to discharge and to enlarge. The mass began to increase in size and he began to lose weight. He was admitted to the hospital and an incision was made below and to the right of the former incision for the purpose of entering an abscess cavity not adequately draining, or obtaining a satisfactory specimen if a tumor instead of an abscess should be found to be present. The incision revealed a cystic tumor with a large cavity in the centre filled with mucoid material. Cultures of this were sterile but a specimen of the wall showed intestinal mucous membrane with a somewhat irregular glandular formation but with no evidence of malignancy. The pathologist thought that the diagnosis lay between a pseudomyxoma or an enterocystoma.

A barium enema was then given to see if the location of the fecal fistula could be determined but the barium seemed to pass through a flattened sigmoid coursing around the tumor and no connection with the fecal fistula was seen. However, when a tube was inserted into the fecal fistula it was seen under the fluoroscope to pass over to the right side of the abdomen to the site of the appendix. This seemed to indicate that the tumor was of appendiceal origin. The necessity of closing off the fecal fistula seemed obvious. Through a McBurney incision it was found that the appendix was completely involved in the tumor and the cæcum was adherent to it. It was necessary to amputate the cæcum in order to shut off the cæcum from the fecal fistula. This diminished the flow from the fecal fistula but did not stop it and subsequently it was found that both the ileum and the sigmoid were pouring fecal material into the tumor. The next operation was devised to cut off both the ileum and sigmoid from the tumor. This was accomplished by tying a strip of tape around the ileum close to the ileocecal valve, then cutting the ileum across proximal to the tumor, turning the distal end in and joining the proximal loop to the transverse colon. The sigmoid was then cut off proximal to the tumor, the distal and inverted and the proximal end was brought out as a lateral, permanent colostomy. The tumor is now cut off from the fecal flow, formed stools are being passed by colostomy and the patient is rapidly gaining strength in preparation for further treatment of the tumor.

The term pseudomyxoma peritonei was used by Werth,<sup>1</sup> in 1884, to describe cases of ruptured ovarian tumors which transplanted ovarian tissue in various parts of the peritoneum giving rise to secondary benign or malignant mucoid tumors. Fraenkel,<sup>2</sup> in 1901, was the first to describe a similar tumor derived from a ruptured cyst of the appendix. In 1912, Eden<sup>3</sup> and in 1916, Bailey<sup>4</sup> described cases in women in which both appendix and ovary seemed to be involved. Seelig<sup>5</sup> and others believed that all cases in males arise from cysts of the appendix. In 1915, Dodge<sup>6</sup> reported ninety-five cases of appendiceal cysts and fourteen cases of pseudomyxoma peritonei resulting from appendiceal cysts. Masson and Hamrick<sup>7</sup> have recently reported six cases of pseudomyxoma peritonei of appendiceal origin, five of which were in women showing no involvement of the ovaries. Naeslund<sup>8</sup>

has written what is perhaps the most authoritative monograph on this subject in which he deals fully with clinical and experimental phases of the subjects. After the tumor has become established in the peritoneum its complete eradication is most difficult. The case presented illustrates some of the difficulties which may arise.

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# CONGENITAL DUODENAL STENOSIS

CASE I.—DR. CHARLES E. FARR presented a boy, ten years of age, who had suffered since birth from symptoms suggestive of partial pyloric occlusion. A gastro-intestinal X-ray series had shown a partial duodenal occlusion, presumably by bands. The boy was sent into the private pavilion of the New York Hospital January 16, 1933, and after two days' rest was operated upon.

The previous history of this boy was of extreme interest. From birth, even while nursing, there was difficulty in retaining food, and growth was quite delayed. Dentition, walking and talking, however, appeared at the normal periods. From eight months of age when artificial feeding was instituted, with a gradual use of varied foods, there developed periods of abdominal distress and vomiting. These increased in frequency and severity until the present. They now occur every two or three weeks, last two or three days, and are accompanied by moderately severe pain in the epigastrium, and headaches. Severe constipation has been a marked feature from birth.

The physical examination was entirely without noteworthy features.

At operation January 18 under ethylene and ether anæsthesia, the stomach was found moderately dilated and hypertrophied, the pylorus was normal. The first and second portions of the duodenum were dilated and the third portion appeared normal. There was no distinct constriction of the lumen of the bowel. The gall-bladder was somewhat enlarged but otherwise normal. Scattered along the common duct were a series of enlarged lymph-nodes—the largest of these was two centimetres in diameter, somewhat firm and extending retroperitoneally as far as the fossa of Treitz. No focal lesion could be found in the neighborhood to account for these nodes. The entire mass was, perhaps, a small half-handful. There were no other palpable nodes in the abdomen. The largest of these nodes pressing on the common duct was excised and during this process a number of finger-

## CONGENITAL DUODENAL STENOSIS

like bands were disclosed, crossing the nodes and passing over the duodenum. These were severed. There was moderate oozing from the bed of the lymph-nodes. A cigarette drain was placed to the common duct. Further exploration showed nothing abnormal except a very marked redundant sigmoid, which even under the anæsthetic was spasmodically contracted and contained many small scybala. The appendix seemed normal but was removed in course. The wound was closed in layers.

The child was slightly shocked by the manipulations around the common duct. He made an excellent recovery and did not vomit once after the operation. The highest temperature post-operative was  $100.4^{\circ}$ . Highest pulse, 124. Within three days the child was quite comfortable and began to take nourishment better than he had done and became much more cheerful. He made excellent progress, leaving the hospital on the thirteenth day. He was sent to the country home of the hospital.

He has improved remarkably in temperament and habits and considerably in weight. He now weighs twenty-four kilograms and his height is 132 centimetres. The wound is soundly healed. His bowels move regularly every day with the use of a little mineral oil. His appetite is good. He has become cheerful and happy and no longer has evidence of duodenal stasis. The microscopical examination of the lymph-nodes showed a simple hyperplasia. Clinically they resembled Hodgkin's disease.

This case was presented as a combination of physical disability by congenital bands, complicated by a mass of hyperplastic nodes along the common duct of origin unknown.

CASE II—DOCTOR FARR also presented a colored child, two years of age, who entered St. Mary's Hospital for Children April 12, 1932. The chief complaints at that time, apparently of only a few weeks' duration, were fever, coryza, malaise, and vomiting. For one week he had vomited all fluids and food except ice cream. The history was very inadequate as there was no possibility of obtaining accurate knowledge of his early infancy.

The physical examination was negative except for very moderate signs of rickets, as evidenced by beading of the ribs and a large liver. Vomiting became a more pronounced feature. In spite of infusions, clyses, and, finally, a transfusion of whole blood the child's general condition steadily declined. Numerous X-rays were taken. April 14 there appeared an inflammatory process at the root of the right lung, apparently not involving the parenchyma.

April 18 a barium meal was given. It showed the œsophagus considerably dilated at the lower end, due to a herniation of the cardiac end of the stomach through the diaphragm. This had caused elongation, dilatation, and tortuosity of the œsophagus. Apparently there were also inflammatory changes about this portion of the stomach, giving a definite mediastinitis. The stomach showed no evidence of organic lesion. It was triangular in shape and regular in outline. At six hours there was some gastric retention but the barium spread throughout the colon.

April 20 air inflation of the colon showed the sigmoid to be remarkably redundant, the distal portion covering the entire colon.

The clinical data were of no especial importance. May 10 an exploratory operation was performed through a left rectus incision, with a transverse limb added. The herniation was easily demonstrated. It admitted two fingers and there were about two inches of the cardiac end of the stomach passing through the gap. This was easily reduced and the excess of the gap was closed with linen sutures, after the passage of a stomach tube. It



was noted at the time that the stomach was dilated but no further exploration was carried out

The post-operative recovery was very stormy and conditions grew steadily worse. There was no relief whatever of the vomiting. Ten days later, May 20, the wound was re-opened. It was found there had occurred a subcutaneous separation of the tissues. The stomach and bowels were moderately dilated. There was a little free fluid and some fibrin. On exploration a firm band was found beneath the liver, arising from its under surface and passing part way around the anterior surface of the duodenum causing a considerable degree of constriction. This band was cut between clamps. This increased the size of the duodenal tube considerably but it was deemed wise to do a posterior gastrojejunostomy. The recovery from this operation was uneventful. The child ceased to vomit and has done well ever since, barring the usual complications of childhood.

He has gained in strength and general health. He does not vomit, his bowels are regular, the wound is soundly healed and apparently the operation has been a success.

A barium X-ray taken February 20, 1933, showed the same bulging out of the lower end of the œsophagus, apparently a part of the cardiac end of the stomach extending through the opening in the diaphragm and presenting partly above the diaphragm. The outline of the stomach was normal but at six hours there was a very definite gastric retention, probably due to the barium retained in this small herniated pouch.

Doctor Farr stated that these cases of partial duodenal occlusion by bands are nearly always complicated by other features. It is well known that congenital malformations are apt to be multiple. All we can hope to do is to relieve the load where it bears the hardest.

DR EDWARD J. DONOVAN said that he operated on a similar case two years ago. The patient was a boy four years of age who had had vomiting attacks since birth. X-rays showed almost complete gastric retention at nine hours. At operation three distinct bands were found lying across and binding down the duodenum. Convalescence was smooth. He has had no vomiting attacks since. The speaker has seen three cases of duodenal stenosis in the new-born. These cases were operated upon at the Babies Hospital by Doctor Bolling. Retrocolic duodenojejunostomy was done. Two cases survived and were completely relieved. One patient died.

DR JOHN C. A. GERSTER presented a specimen from a child eight years of age who had been in the Lenox Hill Hospital four or five times, in the year prior to his death, for a foreign body in the thigh, abscessed tonsils, rickets and tonsillectomy. He was last admitted December 10, 1932. He had been obstinately constipated, requiring the frequent administration of cathartics. For three or four months he had vomited about three times a week, usually after supper. He was always underweight, poorly developed and pale. Like Doctor Farr's first case, this child was extremely intractable, almost impossible to manage. He was admitted in a very weak state and continued to vomit after admission. The vomitus contained no free hydrochloric acid. In spite of the intravenous administration of glucose and subcutaneous administration of saline, he became weaker and died on the third day after admission. At autopsy, the stomach, duodenum and first two centimetres of the jejunum were found to be markedly dilated. The jejunum turned sharply on itself about two centimetres below the duodenojejunal

## CICATRIX OF NECK AND AXILLA PLASTIC REPAIR

flexure At this point there was an extrinsic band surrounding the jejunum and markedly constricting the lumen

## CICATRIX OF NECK AND AXILLA PLASTIC REPAIR

DR CONSTANTINE J MACGUIRE, JR, presented a girl (Figs 1 and 2) now almost thirteen years old

Six years ago her clothes caught on fire, and her neck, chest, and left arm and axilla were severely burned When this burn healed, the resulting cicatrix contracted and finally brought about a condition such as shown in Figs 1 and 2 where her chin was bound down almost to her sternum, keeping her mouth wide open, and drawing the lower teeth forward The left arm was bound to the side from the shoulder to the elbow with a dense mass of adhesions, completely obliterating the axilla



FIG 1—Cicatrix of neck and axilla

FIG 2—Left side view

She was operated upon four times in the King's County Hospital, but without much improvement She was admitted to Bellevue Hospital in September, 1932 The neck was first attacked The skin on the back had been used up in previous operations, so a long tube pedicled graft was first made, extending from the right axilla down to the right groin (Fig 3) A bridge was left half way down as it was feared so long a tube might not be viable After two weeks the bridge was divided so that one long free tube from axilla to groin was obtained

After another two weeks all the scar tissue was excised from the neck, and it was astonishing to see how fibrosis extended down under the sternomastoid muscle so that there were no fascial planes to be recognized The tube was detached over the groin, opened up, and placed in the upper half of the bare area in the neck, and sutured in place (Fig 4) Two weeks



FIG 3



FIG 4

FIG 3—Showing the location from which the long pedicle graft was obtained from the right side  
 FIG 4—The scar tissue of neck excised and raw surface covered by the long pedicled graft from the right side



FIG 5—Site from which the second graft from the left side of the back was taken The scar tissue in the axilla has been excised

## CICATRIX OF NECK AND AXILLA PLASTIC REPAIR

later the base of the pedicle in the right axilla was divided and the tube opened up and placed in the lower half of the large gap left in the neck. Both these transfers remained viable.



FIG 6—The axilla graft in place

Now the left axilla was attacked by taking a tube from the back on the left side (Fig 5), but making this tube with the skin turned in instead of



FIG 7—The ultimate result obtained

outward. An incision was made posteriorly and anteriorly through the web of the scar tissue at the point where the apex of the axilla should be, and

the tube was forced through by blunt dissection from behind forwards and sutured to the edges of the anterior wound (Fig 6)

Ten days later the large axillary web of scar tissue was completely divided from below upwards, exposing the buried tube which was opened up, found viable, forming a new apex to the muscle, with the skin surface facing downwards (Fig 7)

Several more operations were necessary to improve the suture lines in the neck and also to plant pinch graft in the bare area on the left side of the chest

#### MARGINAL GASTRIC ULCER SUBTOTAL GASTRECTOMY

DOCTOR MACGUIRE presented a man, now fifty-two years of age, whom he first saw during 1923, when suffering from a duodenal ulcer which had failed to respond to medical treatment. A posterior gastroenterostomy was done and he was completely relieved of all his symptoms until June, 1930, when he began to have epigastric distress and vomiting, no pain.

In March, 1931, vomiting became much worse, both before and after meals, pain became very severe, but was somewhat relieved by vomiting. On one occasion the vomitus was bloody. His condition became progressively worse until October, 1931.

At operation done October 14, there was found a mass of very dense adhesions, a result of the former operation. In the jejunum, just beyond the gastroenterostomy stoma, there was an indurated ulcer which was penetrating the posterior wall of the transverse colon. The adjacent colon, stomach and jejunum were all markedly inflamed, with induration extending down almost to the base of the mesentery. The duodenum was abnormally distended and greatly deformed, due to adhesions to the liver. The old duodenal ulcer had apparently healed.

The distal two-thirds of the stomach was removed after resecting the jejunum with an end-to-end anastomosis. A long loop of the jejunum was brought up anterior to the transverse colon and anastomosed to the open end of the stomach.

The patient made a good recovery and has been to the present entirely free from any untoward symptoms. There are practically no restrictions on his diet and he has fully recovered his strength, but he is still under weight which is not an uncommon finding after subtotal gastrectomy.

Recently a test meal was given and it showed a total acidity of 60, free hydrochloric 25. This is rather surprising as this stomach was resected very much proximal to the gastroenterostomy, and at least half the stomach was removed. His blood showed a normal count.

This case is shown for three reasons. First, as a marginal ulcer occurring almost nine years after gastroenterostomy, and, therefore, not attributable to operative technic. Second, as an example of the anterior Polya method of resection which is the most satisfactory as a routine measure. It is the easiest, does not require any enteroenterostomy and does not constrict the colon. It makes subsequent operation easier. Third, it is shown as evidence that a very large portion of the stomach can be removed and a very definite acidity persist.

DOCTOR MCCREERY said that at Bellevue it has been the practice to follow patients operated on for gastric or duodenal ulcer for seven years. Most of the recurrences of symptoms developed within the first two years, but one of the Bellevue cases had been entirely free from symptoms for eleven years.

## OMENTAL BAND OBSTRUCTING PYLORUS

before developing signs of a marginal ulcer. Since 1920 there have been seventeen cases of marginal ulcer operated upon on the First Surgical Division, sixteen men, one woman. The original operation in three cases had been done for perforated ulcer, in twelve for duodenal ulcer, and in two for gastric ulcer near the pylorus. In one case the original operation had been a pylorotomy. In all the others a posterior gastroenterostomy, in some case accompanied by cautery destruction or excision of the ulcer. Fourteen of the seventeen patients developed symptoms of marginal ulcer within two years, two between three and four years and one eleven years after operation.

In two cases the secondary pathology was a perforated jejunal ulcer, in five a jejunal ulcer—all on the efferent loop—and in eight true marginal ulcer. In two cases there was a stenosis but no apparent ulcer. In three cases the duodenal ulcer was thought to be still active.

The operative procedure in secondary operation consisted in the perforated cases of enterorrhaphy. And in five cases of excision of the original gastroenterostomy. In these cases the adhesions were so marked or the duodenum seemed so normal that no further procedure seemed justifiable. Resection was done in the remaining ten cases. The follow-up on this group of cases has shown that partial gastrectomy is by far the most satisfactory operation when the patient's condition justifies it, the late results in this group having been much more satisfactory than in those in which some less radical operation was performed. He had come to regard the anterior Polya operation as the method of choice. It was simple, easily performed and in the cases where some later procedure becomes necessary it allowed a much more satisfactory access to the operative field. The operation has been done as a routine on the First Division without an enteroenterostomy. The latter procedure has usually been considered necessary or at least advisable in the prevention of an obstruction due to angulation. In his experience at Bellevue Doctor McCreery had not found this additional step necessary as in none of his cases had an intestinal obstruction developed.

## OMENTAL BAND OBSTRUCTING PYLORUS

DOCTOR MACGUIRE presented a woman, forty years old, who entered St. Vincent's Hospital, March 30, 1932.

For seven months she had been suffering from vomiting, nausea, eructations of gas, pain in the right shoulder, and seventeen pounds' loss in weight. The onset was in August, 1931, and the attacks had been periodic, at about weekly intervals until recently, when they were almost continuous, except when she was resting in bed.

Physical examination was essentially negative except that an X-ray of the stomach showed deformity and obstruction in the pyloric region.

Operation was performed April 8. The gall-bladder was normal, but extending from the gastrohepatic omentum, across the pyloric portion of the stomach to the gastrocolic omentum, there was a narrow, round omental band, which definitely constricted the lumen of the pylorus. It was adherent to the anterior surface of the stomach. There were many fibroids in the uterus.

When the adhesion across the pylorus was divided, there was immediate relief of the obstruction. The appendix was also removed.

The patient made an uneventful recovery and since operation has been entirely relieved of her former symptoms. A set of X-ray pictures taken about six weeks ago show no evidence of recurrence. Such a constricting band must be considered as possibly congenital as there had been no previous operation, no gastric or duodenal ulcer, and no evidence of a cholecystitis.

#### ACUTE PANCREATITIS

DOCTOR MACGUIRE presented a woman who was admitted to St Vincent's Hospital, October 24, 1925. She was then nineteen years of age, previous history essentially negative.

Three months before five days after labor, she had a severe pain in the right hypochondrium radiating to back, accompanied by vomiting. This disappeared after four to five hours. Recurrence in one month. This attack more severe, confining her to bed for five days and accompanied by jaundice. Finally all the symptoms subsided until twenty-four hours before admission, when she had a severe attack of pain associated with vomiting. On admission temperature 101°, pulse 110, white cells 19,000 with ninety-three polymorphonuclears, abdomen generally rigid and tender with both symptoms much more marked in the right upper quadrant. No mass.

Operation was delayed for three days without any improvement. Finally, on opening the abdomen, there was no free fluid, the tissues bled very easily, the omentum appeared abnormally bright yellow in color and was markedly cedematous. The gall-bladder was not acutely congested and not distended. It contained many small mulberry stones and three large non-facetted stones. No obstruction in the common or cystic duct. The stomach was not distended but was pushed forward by a very large retroperitoneal mass which proved to be the pancreas. It was uniformly enlarged throughout head, body and tail. It was very boggy and a finger could be pushed into it without difficulty for at least two inches. No fat necrosis or port wine exudate was seen.

The gall-bladder was opened, emptied of stones and drained with a Mayo drain inside of two rows of purse-string sutures. Two holes were punched in the pancreas through the lesser omentum and cigarette drains inserted. After a stormy two or three days she made a good recovery.

October 10, 1931, she was seized with hypogastric pain localizing in the right lower quadrant and vomiting. Was admitted to the hospital where she gave a picture of acute appendicitis with 20,000 white blood-cells and eighty-six polymorphonuclears.

Emergency operation gave the following findings. Pancreas showed induration of the head but body and tail seemed normal. Gall-bladder normal in color and texture and emptied easily under pressure, no stones could be found and neither could the site of the drainage in the gall-bladder wall be determined. Ducts appeared and felt normal, the stomach and duodenum adherent to the scar and bound in adhesions to the visceral surface of the liver. The appendix was rolled up in a mass of cedematous omentum and was very long, markedly congested and gangrenous in its distal half, but not ruptured. The appendix was removed and the patient made an uneventful recovery.

DR JOHN DOUGLAS said that eleven years ago he wrote a paper on what he termed acute pancreatic necrosis. His interest was revived recently and he reviewed about fifty histories of pancreatic lesions in the record room of St Luke's Hospital. Regarding the etiology and subsequent course of the disease, he was more confused than he was eleven years ago. Thirty-four

## REPORT ON CERTAIN ARTHRITIC AND VASCULAR CASES

cases were diagnosed as acute pancreatitis. In six of those that were operated upon for an acute pancreatic lesion, four in St. Luke's Hospital and two in other hospitals, there subsequently developed a pancreatic cyst or some other pancreatic lesion. In one case, a large cyst developed, three weeks after operation, which showed at that time the pancreas to be hard and indurated. Another had three cysts form subsequent to an operation for an acute pancreatic necrosis and on two occasions required drainage of these cysts. Another patient was operated upon for an acute pancreatic necrosis and came back within two years when an X-ray showed a calcified area in the tail of the pancreas. In other cases where there were gall-stones in the gall-bladder or common duct and a relatively slight pancreatic lesion was found at the time of operation, the patients died and at autopsy the pancreas was found to be gangrenous. Several patients discharged as cured or improved returned to the hospital in ten days up to seven years, having been apparently well during the time between their discharge and readmission to the hospital with an acute pancreatic lesion. Another case which was operated on for a gangrenous pancreas was shown at autopsy to have had previous attacks. There are many clinical contradictions to what has been taught regarding the etiology and treatment.

DOCTOR MACGUIRE rejoined that in his opinion the patient who has had pancreatitis is exposed to further trouble. These cases frequently return subsequently with some type of suppurative pancreatitis and die. He had punched two holes in this woman's pancreas on the principle that one should drain the swollen pancreas even where there is no fat necrosis and he believed her good condition up to now was the result of so doing. The gall-bladder was not distended but contained a number of stones. Disassociated from the problem of the pancreas it had been of interest to discover subsequently that a gall-bladder can be insulated as this one was and still present a blue, thin-walled organ. The speaker had not known that such a thing was possible.

## THERAPEUTIC EFFECTS FOLLOWING INTERRUPTION OF THE SYMPATHETIC NERVES. REPORT ON CERTAIN ARTHRITIC AND VASCULAR CASES

DR. RUSSEL H. PATTERSON read a paper with the above title.

DR. WENDELL J. STAINSBY (by invitation) emphasized the ease with which Doctor Patterson had been able to reach the sympathetic region. In only three of the cases was there failure to get marked effects. The subsequent symptoms of neuritis, hyperesthesia and Horner's syndrome with one or two exceptions were only temporary, passing off in a day or two. He had been disappointed that the operation had not seemed to have any great effect on the course of arthritis, although symptoms related to vasomotor abnormalities were relieved. Understanding of the effects of sympathetic bloc is just beginning and Doctor Stainsby believed this procedure would have a prominent place in the future treatment of vascular disturbances, particularly when the extremities only were affected.



# BRIEF COMMUNICATIONS

## LIPOSARCOMA

LIPOSARCOMATA occur usually in the thighs or in the retroperitoneal tissues. Other frequent sites are about the kidneys, forearms, and mid-line of the back. Less frequently they are seen in the face, pleural cavity, joint spaces and the subcutis. Lifvendahl<sup>1</sup> reported a case occurring bilaterally in lactating breasts with a fatal outcome within seven months. Stewart<sup>2</sup> recorded three cases that, according to the evidence, were primary in bone-marrow. Caldwell and Zininger<sup>3</sup> saw a case arising in the fat of the extradural space of the lumbar spine.

These tumors occur chiefly in patients of middle age and the sexes are affected about equally. They usually have been present from one to three years before medical aid is sought. Liposarcomas characteristically grow slowly and tend to be encapsulated but do invade the surrounding tissues and blood vessels. As a rule metastases are late manifestations of this tumor. Reports of large tumors are not uncommon, the largest being that of Hirsch and Wells,<sup>4</sup> which weighed sixty-nine pounds.

The symptoms of liposarcoma usually are those of a tumor mass or deformity. When the size of the growth interferes with the normal function either of abdominal or of thoracic organs, symptoms of compression may appear. Weakness, loss of weight and strength, and anorexia are occasional complaints, as is the case with any malignant tumor. In the larger tumors, necrosis of the centre of the mass or the presence of hæmorrhage into the centre of a large tumor cause characteristic symptoms.

The diagnosis usually is not made before operation and indeed sometimes may be made only with difficulty microscopically. The microscopical picture may be one of very early undifferentiated tissue with but little fat or the cells may be predominantly of the adult type. Ewing<sup>5</sup> pointed out that these cells may be large granular cells or small round or polyhedral cells with no sign or clue as to their origin. Because of this variation between the two extremes, microscopical differentiation may be extremely difficult and must include endothelioma and hypernephroma as two tumors of close resemblance. Unless liposarcoma is suspected and a fat stain done the true nature of the growth may be missed altogether. Care must be exercised to exclude sarcoma developing in a preexisting lipoma.

Several authors have correlated the findings in liposarcoma with embryological fat tissue in an effort to determine the true origin of the fat cell. Jacobson<sup>6</sup> feels that the fat cells are closely related and derived from the fibroblast. Robertson<sup>7</sup> concluded that the fat represents a definite type of tumor tissue closely related to the myxomatous elements that are so frequently reported in connection with liposarcoma.

## LIPOSARCOMA

The prognosis, of course, must be guarded when dealing with this type of tumor

The treatment of choice, wherever such is possible, is wide excision Selman<sup>8</sup> and Stewart have reported good results with Rontgen therapy

CASE—The patient, white, female, twenty years of age, was first seen in the Cleveland Clinic January 13, 1932 Her complaint was "a lump in the left leg" Her

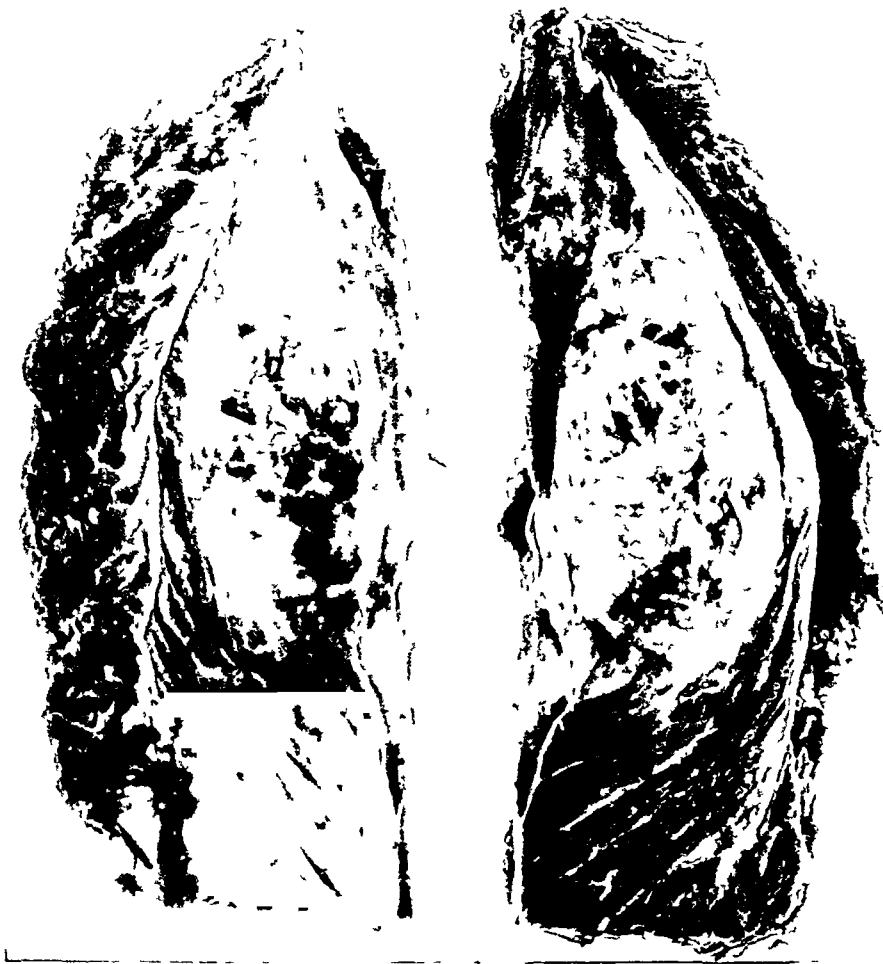
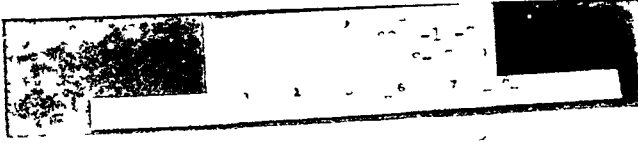


FIG 1—Longitudinal section through excised tumor mass

illness began three years before at which time the lump first had been noted on the outer aspect of the left thigh The patient recalled that about three months before she noticed the lump, she had received two distinct injuries to the left thigh The mass had increased slowly in size but had caused no discomfort whatever One year after the lump was noted it was excised A few months after that excision the mass reappeared and had grown slowly to the time she presented herself One week before admission at the clinic a portion of the tumor had been removed and examined elsewhere Through the courtesy of Dr Thomas L Ramsey, of Toledo, Ohio, we were able to obtain a

## BRIEF COMMUNICATIONS

portion of the tumor, on which the microscopical diagnosis was, "primary vascular endothelioma arising from the vessels of the muscle tissues and showing activity of growth"

The patient's family history and her own past history were not pertinent to her complaint. There was no history of hæmaturia or other genito-urinary difficulty.

Physical examination revealed nothing of significance except the local lesion on the leg. No kidney masses were palpable and there was no clinical evidence of disease in the lungs or abdomen. On the outer side of the left thigh in its lower half was a large hard tumor with a recent operative scar extending over it. The mass measured about eight inches by five inches and projected above the normal surface of the thigh for two inches. It was tender, because of the recent operation, and appeared fixed to the underlying structures. One lymphnode was palpable in the left groin.

A rontgenogram of the chest showed no evidence of metastases. Examination of



FIG 2 —Microscopical section of liposarcoma  
( $\times 150$ )

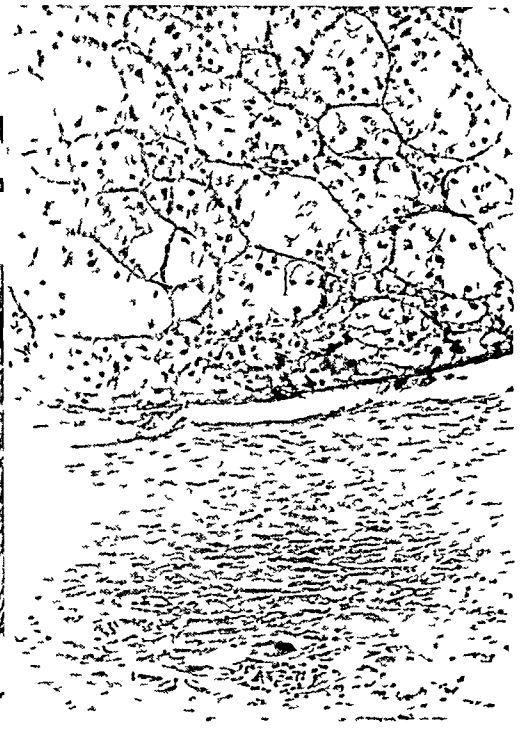


FIG 3 —Microscopical section of liposarcoma  
( $\times 150$ )

the urine revealed nothing abnormal. Complement fixation reactions were negative. Mild secondary anæmia was present.

A biopsy of the left inguinal node was done on the day following admission and the pathological diagnosis was subacute inguinal adenitis. Two days later the tumor was excised widely through a linear incision extending the full length of the thigh on its anterolateral surface. The operation revealed a rather firm movable tumor mass (Fig 1) about eight centimetres in diameter in the rectus femoris muscle, at about the junction of the lower and middle thirds of the thigh. The entire tumor mass was resected, taking with it a wide border of the rectus femoris muscle itself. The patient's convalescence was uneventful and she left the hospital twelve days after operation.

The microscopical study of the tumor (Figs 2 and 3) by Dr Allen E. Graham showed that there were numerous sections containing muscle, fascia, fatty tissue and neoplasm. There were numerous areas of inflammation, degeneration, necrosis, thrombosis and granulation. In connection with the latter there were occasional giant cells of the foreign-body type.

The tumor tissue was of uniform character and consisted of an alveolated mass of

## LIPOSARCOMA

large, closely packed, vacuolated cells, with round or oval, vesicular nuclei forming solid nests, separated by a very fine, vascularized stroma. At first glance the general arrangement and character of the cells suggested the possibility of hypernephroma. In some areas, the alveoli were quite large and had spaces in the centre, many of which contained red cells. Some of these spaces appeared to be lined by a single layer of high cuboidal or columnar cells. Such areas suggested angio-endotheliomatous neoplasm. Frozen sections, stained with sudan and thionin, showed large quantities of lipid material in the form of fine and coarse globules in a large number of the tumor-cells.

The tumor tissue was scattered throughout the muscle and tendon or fascia. It did not infiltrate diffusely, but showed striking tendency to remain localized in small and large lobules separated by dense bands of fibrous tissue. In some of the sections it seemed possible to trace the origin of the neoplasm in the lobulated, fatty tissue. The pathological diagnosis was liposarcoma of the left thigh.

In one portion of the tumor, cells histologically similar to the tumor-cells were present in the small blood-vessels. Whether this represented actual invasion of the blood-stream or whether the tumor was forming a polyp in the blood-vessel could not accurately be determined. Examination of the piece of tissue removed at the operation elsewhere on January 1 showed in much plainer detail, without the presence of the post-operative reaction, the lipoidal nature of the tumor. It could readily be determined that this was a tumor arising from fat cells and not a connective-tissue tumor arising in fat.

Sections of the tumor were sent to the department of pathology at the Memorial Hospital, New York City, and were reported as typical of liposarcoma. Doctor Karsner, of the department of pathology, Lakeside Hospital, Cleveland, also agreed with the diagnosis of liposarcoma.

The nomenclature relating to liposarcomata as found in the literature is exceedingly confusing. Until recently, authors have used descriptive terms of the predominant type of tissue present. Thus we find such terms as lipomyosarcoma, liposarcoma, myxomatodes, lipoma myxomatodes, myxoliposarcoma and lipoma sarcomatosum. No doubt these tumors exist as entities, but also liposarcoma, a tumor arising from fat-cells, exists as an entity. We believe the tumor in this case to be of the latter type, a true liposarcoma.

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## TUBERCULOUS ABSCESS OF THE SPLEEN

TUBERCULOSIS of the spleen has been classified as both primary and secondary By primary tuberculosis it is not meant that the spleen is the portal of entry of the infecting organism or even the first tissue of the body in which the disease manifests itself, but that the diseased process may localize itself in the spleen and act as a focus for dissemination of the tubercle bacilli, while the original focus may be healed entirely The primary type is characterized by rather typical symptoms and signs, and the individual may be cured by splenectomy Secondary tuberculosis of the spleen is not uncommon and is associated with active tuberculosis of other organs

Winternitz,<sup>1</sup> in 1912, collected and tabulated fifty-one cases of primary tuberculosis of the spleen Sixteen of these cases were operated upon, with nine recoveries The operative series included one case in which a splenectomy was not done because of adhesions, and two cases in which the spleen was sewed to the abdominal wall and the cold abscess allowed to drain Winternitz' analysis of the fifty-one cases may be briefly summarized as follows

Tuberculosis of the spleen seems to be equally frequent in the male and female sex It is most frequent between the ages of twenty and forty, but may occur at any age The youngest in his tabulated list was one year and the oldest eighty years of age The symptoms may run an acute or chronic course In the acute cases the symptoms were those of an acute systemic infection, and in the chronic cases the onset was characterized by pain or tumor in the splenic region There may be, in addition, gastrointestinal or respiratory disturbances In the list of fifty-one reported cases, the blood count was given in twenty-six It was normal in nine (34.61 per cent), showed anæmia in eleven (42.30 per cent), and a polycythæmia was present in six (23.08 per cent) The anæmia was not marked in any instance, 3,200,000 red cells being the lowest count As a rule the leucocytes were not increased, and their number seemed totally independent of the number of red blood-cells

The association of polycythæmia and tuberculosis of the spleen was first noted by Rendu and Widal<sup>2</sup> Douglas and Eisenbrey<sup>3</sup> report a case of tuberculosis of the spleen with infarction and polycythæmia Since many cases of polycythæmia have been noted in the absence of splenic tuberculosis, a direct relationship is open to some question

Of the cases reported as primary tuberculosis of the spleen only a small percentage have shown definite abscess formation Winternitz mentions a cyst of the spleen reported by A M Hayden which was apparently a cold abscess Magnac<sup>4</sup> records a tuberculous spleen in a fourteen-and-one-half-year-old girl which was removed at operation and found to contain a liter of pus Another definite case was operated upon by Peck<sup>5</sup> and a spleen weighing 3,270 grams was removed, which contained an abscess eleven centimetres in diameter The diagnosis was confirmed in his case by injecting the splenic pus into a guinea-pig

We have recently treated a patient at the University of Kansas Hospital, who was found to have an unusually large cold abscess of the spleen without clinical evidence of involvement of other organs

CASE REPORT—A G, colored, female, aged twenty-two years, was admitted to the hospital July 19, 1930 About two years before admission she noticed a mass the size

## TUBERCULOUS SPLEEN ABSCESS

of a small orange just under the left costal margin about five inches to the left of the mid-line. This mass remained stationary in size for about two months. Following this period it began to grow rapidly. She noticed that the mass was chiefly confined beneath the ribs and appeared to be pushing the ribs outward. During the succeeding months there appeared to be a gradual increase in bulging of the ribs. In January, 1930, the rib margin receded somewhat and the swelling appeared somewhat lower in the left abdomen. In March, 1930, it filled the entire left abdomen (Fig 1). She was able to feel



FIG 1—Appearance of abdomen with patient standing erect

a splash as if there were fluid in the abdomen. She has had no discomfort from the mass, except about one week before admission to the hospital, when she had some pain over the bladder region for one day only. She has had no urinary or menstrual disturbances. There has been some loss of weight and strength.

On admission to the hospital she had a normal temperature with an unstable pulse ranging from 85 to 120. During the succeeding week the temperature on several occasions rose to  $101^{\circ}$  and at one time reached  $103^{\circ}$ . Part of the time the temperature was within normal limits. Emaciation and anæmia were marked.

## BRIEF COMMUNICATIONS

The mass in the left abdomen extended from the diaphragm to the pubes and beyond the mid-line on the right. This mass appeared to fill the entire left abdomen. There was a definite fluid wave in this mass. It was not tender, nor did it move with respiration. At the lower margin of the mass there was a firm area with some irregularity. Blood chemistry was within normal limits. Kidney function test was normal. A catheterized specimen of urine showed a few pus-cells. The Wassermann and Kahn tests were both four plus. The blood examination showed a secondary anæmia with 3,400,000 red cells, 52 per cent hæmoglobin and 6,850 white cells with 70 per cent polymorphonuclears.

The X-ray report is as follows. Skiagraph of the kidneys, ureter and bladder shows the right kidney in normal position with what appears to be a normal pyelogram. The left kidney is displaced to the right and lies at the angle made by the spine and the crest of the right ileum. The entire left abdominal field shows a large homogeneous, uniform



FIG 2—Drawing of spleen showing general form and large abscess cavity

shadow, suggesting a large tumor mass, which has crowded the left kidney over to the position it now occupies. Skiagraph of the chest shows the lung fields clear, except for some slight infiltration in the right costophrenic angle. The diaphragms are elevated, but the contours are normal. No evidence of active lesion in the lungs.

Exploratory operation was done July 29, 1930, and a large splenic tumor exposed. This was found to be cystic and on aspiration contained pus. The entire mass was removed with considerable difficulty. It was densely adherent to the diaphragm over a large area. While attempting to free the spleen from the diaphragm it was torn and pus soiled the left peritoneal cavity. The quantity of pus aspirated measured 5,500 cubic centimetres. The spleen was completely removed. The post-operative course was rather stormy for a few days. On the tenth day she developed an enteritis. She became discontented and left the hospital against advice on the fifteenth post operative day. She died

## TUBERCULOUS SPLEEN ABSCESS

at her home eighty-two days after the operation from what appeared to be generalized tuberculosis. An autopsy was not obtained.

The pathological report was as follows. *Gross Pathology*—Specimen consists of a large cystic spleen, measuring twenty by twenty-six by fifteen centimetres (Fig 2). The surface is fairly smooth and symmetrical. There are numerous firm, fibrous, hæmorrhagic, adhesive tags attached to the surface. One surface is purplish-red and measures twenty-two by eighteen centimetres. This represents the flattened-out splenic tissue. One pole of the spleen is uninvolved and hangs from the rounded mass much like the auricular appendage of the heart. It is triangular in shape, seven centimetres across the base, four and a half centimetres from the base to the apex and two centimetres in thickness. The surface of this area is wrinkled and soft and flabby in consistency. The capsule of the spleen proper is markedly thickened. Areas of fibrosis, measuring from one to eight millimetres in diameter, are seen scattered over the surface. The spleen is irregularly thinned by the large cystic cavity. The remainder of the capsule of the spleen covers the entire cystic cavity. The cystic cavity measures twenty-one by seventeen by thirteen centimetres. The cyst wall measures about two millimetres in thickness. It is fibrous and white. The cavity contains friable, whitish-yellow, cheesy material. The internal wall is hæmorrhagic, reddish-yellow, granular and covered with caseous material.

*Histological Pathology*—The capsule of the spleen is considerably thickened. There are some loose adhesions on the surface. A number of thin-walled blood-vessels are seen on the surface. The trabeculæ are prominent. The malpighian bodies are large but poorly defined. Some of the malpighian bodies show a tendency to hyaline change. The terminal arterioles are not particularly abnormal. Throughout the splenic pulp there is considerable infiltration with mononuclear and a few polymorphonuclear leucocytes. Eosinophilic cells are also seen in the stroma. The wall of the abscess is made up of dense hyaline fibrous tissue, along the inner side of which there is some chronic granulation tissue. This chronic granulation tissue frequently shows little tags of circumscribed foci that are poorly defined and also epithelioid cells with here and there fairly typical multinucleated giant cells. The picture is quite characteristic of old chronic tuberculosis granulation tissue.

*Diagnosis*—Chronic splenitis and perisplenitis with a tuberculous abscess.

Two guinea-pigs were inoculated with the pus from the large abscess of the spleen. Both pigs died and at the autopsy many granulomatous nodules were found in the lungs, liver and in the spleen characteristic of tuberculosis.

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## BOOK REVIEW

THE GENESIS OF CANCER By W SAMPSON HANDLEY, M S, Lond, F R C S  
Pp xx + 258 with 113 illustrations London, Kegan Paul, Trench, Trubner & Co, Ltd

To have condensed the results of a quarter of a century's clinical experience and experimental work into a small volume of 250 pages would in any case have been a noteworthy achievement. But, in the volume now before us—*The Genesis of Cancer*—Mr Sampson Handley has done a great deal more than this: he has given us a constructive hypothesis upon the great problem of the origin of cancer, which cannot be better expressed than in the author's own words:

This book states the evidence for the main inference which has been forced upon me by twenty-five years' clinical and histological work upon cancer, namely, that local lymph stasis usually due either to congenital malformation of the lymphatic vessels or to a chronic proliferative lymphangitis, is a constant precursory factor in malignant disease and may therefore be spoken of as its cause. If I am reproached for writing a book merely to establish our conclusion, my defence is that in my opinion that conclusion is the master-key to the Etiology of Cancer.

A careful and exhaustive study of the lymphatic system has been the foundation of most of Mr Handley's best-known work, namely, that upon the spread of carcinoma, and the thesis embodied in the book now under consideration. As he tells us, he found the lymphatic anatomy of the skin so inadequately dealt with even in text books of dermatology, that it was found necessary to explore the whole field and to construct from his own histological researches a workable and coherent view of the cutaneous lymphatic system. It is somewhat remarkable that this subject had so long escaped careful research, or at least that if such research had been carried out its results had, up to that time, been so imperfectly recorded. The intimate association of the lymph with the physical and chemical dynamics of the cell would appear to be an obvious indication for the study of the effects of localized disturbances of the lymph supply, and therefore for a close examination of the lymphatic vessels in those situations where there are abnormalities of all growth. Hitherto this aspect of the case has received but very cursory attention, and the more spectacular phenomena of mitosis, cell proliferation and the like have monopolized the time and care of research workers. The present reviewer well remembers that the late Doctor Klein, when lecturing at St Bartholomew's Hospital, stated his opinion that the lymphatic system was undeservedly neglected and that careful research therein would probably be rewarded by the elucidation of some of the most obscure problems in pathology. With Mr Handley it has already yielded practical results of the utmost importance in demonstrating the method of the spread of cancer. He now asks us to consider the evidence of its part in the production of malignant disease.

The first chapter of the book is devoted to a comprehensive study of the lymphatics of the skin, and is followed by a critical examination of the histological appearances presented by lymphangitis, especially as it occurs in such conditions as lupus, Paget's disease of the nipple and syphilis. In all of these lymphangitis is a prominent feature and all three are, of course, well known to be intimately associated with malignant conditions of the skin, breast and tongue. The one factor which is common to all is lymphangitis, varying in degree according to the development of the disease.

Consideration of the papilloma as a result of lymph stasis forms the subject of the following chapter, and the author records an experiment of his own, which is eminently instructive in this connection. By placing a rubber band around the base of a rabbit's ear, so as to produce a moderate degree of constriction, a very marked hypertrophy of the cutaneous papillæ occurred. In our opinion the cardinal value of this experiment lies in the fact that no extraneous variables such as micro-organisms were introduced: the sole deviation from the normal is an alteration of the "hydraulics" of the local

circulation and the production of lymphatic obstruction. There is no possible question of direct action upon the epithelium itself, such as might be considered to arise from the external local application of chemical or physical irritants. There is papillary hypertrophy simply in consequence of over-nutrition due to lymphatic obstruction.

If this is the case, and alterations in the subjacent lymphatics are the essential precursors of papillomata rather than agents acting directly upon the epithelial cells, it is clear that anything which sets up the necessary changes in the lymphatic vessels—be it coccus, bacillus, spirochæte, or chemical reagent—can by so doing determine the formation of a papilloma. Common warts are by many workers now thought to be infective, upon the view we are now considering the primary action of the infective agent is not upon the cutaneous epithelial cells but upon the subjacent lymphatic vessels and adjacent connective tissue.

Very instructive also are cases of rectal prolapse, where the prolapsed portion of the gut is locally constricted by the sphincter, and one is illustrated where this condition is associated with the formation of stalked papillary adenomata, while attention is also drawn to the fact that such prolapsed portions of the rectal mucosa show marked tendencies to become the site of carcinoma. That papillomata and adenomata are the common antecedents of neoplasms in the tongue and rectum, respectively, is of course well known. What is perhaps not so commonly appreciated is, that both these conditions may exist without any microscopic evidence of their presence. Microscopic examination, even with a low power, will render them evident. The work of Lockhart-Mummery and Dukes in connection with pre-cancerous conditions of the rectum, affords incontrovertible evidence of the presence of these, often microscopic, adenomata in the rectum and of their being precursors of malignant change.

Carcinoma of the breast affords corroborative evidence of the same condition of the lymphatic system. Bonney found traces of chronic mastitis in all the cases of early carcinoma which he examined. Handley finds that in the earliest stages there is marked cell proliferation of the connective tissue, together with a proliferative lymphangitis. In the later stages these initial changes are masked by fibrous tissue of greater or less extent. In the earlier active stages of mastitis distention of the perilobular lymph sinus can be seen, and all the lymphatics of the lobule are distended with lymph. Photographic illustrations of these changes are given. In the later stages the epithelium of acini and ducts begins to show proliferation and papillomatous elevations appear within the ducts. Upon the fact that such proliferation and papillomatosis precede actual malignancy there is now a general consensus of opinion. The point to be emphasized is that it is not the epithelial change which is the primary change, but the initial lymphangitis with its accompanying connective tissue alterations. It is also an observed fact that the induration of chronic mastitis, when the condition has developed so as to be clinically recognizable, corresponds in position to the anatomical mammary lobes, each of which has its own special outlet upon the surface. Infection from the surface, whatever may start it, would therefore tend to produce lesions having a lobular distribution.

Carcinoma of the cervix uteri exhibits an analogous state of affairs in its early stages. Bonney has shown that "a system of connective tissue papillæ and inter-papillary epithelial processes is developed in a situation where these structures do not normally exist, and that epithelial downgrowth is initiated on local areas of plasma-cell proliferation and loss of elastic tissue. And further it has been demonstrated that when the sub-epithelial connective tissue proliferation first takes place the epithelium is actually thinner than normal, and that its hypertrophy only develops after the sub-epithelial changes are established. That which is so clearly seen in the case of the cervix is also true of the other situations that have been studied, namely, that the hypercellularity of the sub-epithelial tissue precedes the multiplication of the epithelial cells." Papillary hypertrophy therefore precedes cancer of the cervix. It is a commonplace that cervical cancer is much more common in parous than in non-parous women, and it is obvious that injuries

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to the cervix with the consequent formation of fibrous tissue will lead to obstructive changes in the lymphatic system of the part, whether septic changes have occurred or not.

Equally instructive is the genesis of X-ray or radium carcinoma of the skin. Wolbach, who, in addition to his own experimental work, has studied histologically the probably unique collection of clinical material placed at his disposal by Porter, insists strongly that the initial lesions of a radio-dermatitis do not occur in the epithelium but in the sub-epithelial connective tissues. Swelling of the collagen fibers is the first obvious result of radiation, and no epithelial changes can be observed until this has occurred, and he goes on to say that he believes the lesions of the epidermis are in all cases secondary to the obliteration of lymphatics and capillaries produced by the primary changes in the connective tissue.

Space does not allow of any further discussion of the clinical evidence brought forward, but it is surely a strong point in favor of Mr. Handley's view that so far from contradicting previous experimental and clinical work it affords a rational basis for explaining the action of such diverse carcinogenic agents as radiations, chemical reagents, trauma and living organisms. Interference with lymph supply means alteration in conditions of nutrition, and since nutrition obviously determines cell growth we seem to be approaching the root of the problems. When it is realized how slight modifications in the electrolyte concentration of the medium in which they are suspended can cause division of certain unfertilized ova, the enormous importance of alteration in the nutritive medium at once becomes manifest.

One further point requires mention. It has been objected that the development of malignancy upon, say, cutaneous papillomata is relatively rare. This is perfectly true. The point insisted on is that prior to the development of carcinoma the papillary—and their antecedent lymphatic changes—must be present. To say that carcinoma is invariably preceded by these changes is not to say that they invariably produce carcinoma. The determination of actual malignancy depends doubtless on many subsequent factors which themselves call for extensive research.

Very striking is the fact that Mr. Handley has arrived at his conclusions firstly on the spread of cancer, and now upon its origin, by the systematic use of ordinary histological and anatomical methods. The newer cytological, physical and chemical lines of research have disclosed facts of fundamental and far-reaching importance which were unattainable by the older methods, nevertheless it is in our opinion a most pernicious delusion to consider that the day of ordinary histological research is past.

The book is one which needs and deserves to be carefully read and studied, and the more this is done, the more, we are convinced, will the fundamental importance of the matters so lucidly presented become established.

H. A. COLWELL

## EDITORIAL ADDRESS

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### ADDRESS OF THE PRESIDENT THE STUDY AND TEACHING AND THE PRACTICE OF SURGERY

BY ARTHUR DEAN BEVAN, M D  
OF CHICAGO, ILL

THE last fifty years have witnessed great changes in the teaching and the practice of surgery. During this period medicine became a science, medicine is today a science as truly as physics, chemistry and biology are sciences. It is not possible to give an exact date to the birth of the science of medicine but one can approximate the date. The science of medicine is based upon anatomy, physiology, pathology and pharmacology. When these daughter sciences of medicine had advanced to the dignity of true sciences, medicine itself then became a science, because medicine is simply the application of these sciences to the study of the cause and the recognition and the cure and the prevention of disease.

*When did this change occur?* This change, of course, was gradual. Many men in many countries helped to bring it about. In its struggle upward through the centuries mother medicine gave birth to a number of daughter sciences, and these children have helped mightily to place her on a scientific basis. Sired by Vesalius, medicine gave birth first to the science of anatomy, sired by Harvey, to the science of physiology, sired by Morgagni, to the science of pathology, and then these children presented the old lady with many grandchildren. Anatomy gave birth to histology and embryology, physiology to biochemistry, pathology to bacteriology.

If we fix an approximate date to the change of medicine into a science we should, I think, take the period of Pasteur's active work and influence. Many men contributed to this great result before the days of Pasteur. John Hunter, the surgeon, Jenner and the English physicians, Sydenham, Bright, Hodgkin, Stokes and others, Cruveilhier, the French pathologist and the

French surgeons of the last century, Malgaigne, Nelaton and Broca, Claude Bernard, the father of modern physiology, the great French clinician, Trousseau, the introducers of anæsthesia Morton and Simpson, the German pathologist, Rokitsansky, and his contemporaries and successors, Virchow, Karl Ludwig, Langenbeck and Billroth, and then came Pasteur, the founder of bacteriology and through the mist of the centuries at last came clearly into view the magnificent figure of the science of medicine. After Pasteur came Lister and Koch and many laboratory and clinical scientists, and medicine was at last and undeniably a science—possibly the greatest of all sciences.

To those of us who have lived through the greater part of this period of rapid transition, the experience has been most interesting, most fascinating. I began the study of medicine in 1880. It may be of interest if I draw for you a sketch of the surgery of that day. My Professor of Surgery was Moses Gunn, one of the founders of the American Surgical Association, and its fourth President. I soon became an assistant in Gunn's surgical clinic and was the registrar who kept the records of the cases examined and operated upon.

The surgical cases were very different from the cases seen in a surgical clinic today. We did very little abdominal work. We had not as yet introduced antiseptic surgical technic, this in our clinic was not done until 1881. The anæsthetic was ether. The operations performed were amputations, removal of tumors, cutting for stone, excising epitheliomas of the lower lip, operating on hæmorrhoids, opening abscesses, setting fractures, reducing dislocations, occasionally ligating a great vessel for aneurysm, draining an empyema, trephining for depressed fracture of the skull, operating for osteomyelitis, dilating urethral strictures, doing an occasional external urethrotomy for stricture or extravasation of urine, opening a perityphlitic abscess, removing tonsils with a tonsillotome, dividing eye muscles for strabismus, doing subcutaneous tenotomies for club-feet, amputation of the breast for carcinoma, operations for the relief of strangulated hernia, laparotomy for the removal of an ovarian tumor, the tapping of hydroceles and the injection into the sac of tincture of iodine to bring about obliteration and cure, the removal of the second division of the trifacial, including Meckel's ganglion, for severe and persistent facial neuralgia, these were among the operations when I was a medical student.

The surgeons were still under the spell of the rapid and brilliant operating of the pre-anæsthetic era. The left lateral lithotomy done by Gunn and his contemporaries was a dramatic and brilliant piece of work. The patient was etherized and held firmly in the lithotomy position. The grooved sound was passed into the bladder and clicked upon the stone, sitting in front of the patient was the surgeon dressed in a frock coat with the cuffs of the sleeves rolled back, with a scalpel the left lateral incision was made down and into the urethra. The surgeon with his left index finger in the wound felt for the grooved sound, he then passed a long narrow probe-pointed knife along his left index finger down to the staff and felt the point engage

in the groove. He then gave a signal to his assistant who carried the sound well into the bladder by depressing the handle of the staff, this carried the knife with it, and incised the urethra and the left lobe of the prostate. The knife was withdrawn, the left index finger was introduced along the staff into the bladder, the staff was withdrawn by the assistant, the surgeon threw his right hand up in the air and an assistant placed the lithotomy forceps in it, the lithotomy forceps was rapidly introduced along the left index finger into the bladder, the stone grasped firmly by the forceps a slight rolling motion of the forceps was made to see that the stone was well grasped and that the forceps were free, and then as in delivering a child's head with obstetrical forceps following the curve of the pelvis, the stone was removed and for an instant the surgeon held the stone up over his right shoulder so that the audience could see—and then applause, and all of this was done within a few minutes from the beginning of the operation. The conditions under which this work was done were very different from those existing today.

S D Gross, the founder of our Association, in an article published in the *American Journal of the Medical Sciences*, 1876, volume lxxi, in which he discusses a century of American Surgery (1776 to 1876) made the following surprising statement:

"Although this paper is designed to record the achievements of American surgeons, there are, strange to say, as a separate and distinct class no such persons among us. It is safe to affirm that there is not a medical man on this continent who devotes himself exclusively to the practice of surgery. American medical men are general practitioners, ready, for the most part well educated, to meet any and every emergency whether in medicine, surgery or midwifery."

This situation continued for some time. Dr George Dock, who was graduated in the 'eighties in Philadelphia, told me that W W Keen, who at that time was recognized as one of the prominent American surgeons, had one of the largest general practices in Philadelphia, and Nicholas Senn, when he left Milwaukee to take the chair of surgery at Rush, was doing a very large general practice.

One can obtain some idea of the surgery of the time by reading the first volume of the *Transactions of the American Surgical Association*, published in 1883, fifty years ago. This contains the papers read in the first three meetings. Although Lister's paper on the antiseptic treatment in surgery was published in 1867, his suggestions were very slowly accepted. Lucas-Championniere in France, and Thiersch and Volkmann in Germany adopted Listerism in the early 'seventies. Lister's work was based at first upon the theory that germs produced suppuration and he sought to exclude them from the wound. This was simply a theory, these pus germs were not demonstrated until Ogston in 1881 and Rosenbach, somewhat later, and Koch finally with solid media were able to grow pure cultures of staphylococci and streptococci and prove conclusively the fact that these pus organisms were the cause of suppuration.

In this uncertain period of about fifteen years, the majority of the surgeons of the world refused to accept Lister's theory. This is very well shown in the first volume of the Transactions of the American Surgical Association. Dr B A Watson, of Jersey City, read an excellent paper on Lister's system of antiseptic wound treatment. Today, of course, the paper seems most convincing and yet the discussion which followed showed that many surgeons refused to accept it. Dr J H Packard, of Philadelphia, who opened the discussion, said, "If I understand the essayist correctly, I must take exception to his statement that the majority of American surgeons have adopted Listerism, certainly on behalf of the surgeons of Philadelphia I feel warranted in saying that it has not in their hands yielded such results as to induce them to adhere to it." Dr Alfred Post, of New York, said, "I think I can say the same in regard to the surgeons of New York, I do not think that any of them now use the method." Dr A Vanderveer, of Albany, said, "I can say the same in regard to the surgeons of Albany and the vicinity." Dr T G Richardson, of New Orleans, said, "There is not a surgeon in our state who uses the Lister method." Dr C H Mastin, of Alabama, said, "We have ceased to use it entirely", and this was the American Surgical Association in 1883.

Fortunately, my own teacher of surgery, Moses Gunn, took up Listerism comparatively early. In the first volume of the Transactions of the American Surgical Association, he presented a paper on the treatment of fractures of the skull, this was read June 1, 1882. Up to that time the accepted treatment in fractures of the skull with depression was to operate and elevate the fragments in compound fracture, but to leave simple fracture with depression severely alone. Gunn took the position that the advantage gained by antiseptic surgery made it possible to operate with safety on simple fractures with depression and elevate the fragments, and he advocated this method of treatment. Gunn was severely criticised. One surgeon in the discussion said, "I think the advice of Doctor Gunn, that we should elevate every depressed fracture, even if it is simple in character, is a very dangerous doctrine."

During my medical course our school, fortunately, came under the influence of two of our younger men who had spent several years in post-graduate work in Vienna and Berlin, France and England, during this period of rapid transition from 1880 to 1882. These men were William T Belfield, who just before his return from abroad studied in Koch's laboratory in Berlin and learned what was then known of the new science of bacteriology, he learned to stain for tubercle bacilli, gonococci, pus organisms, *etc*. Belfield presented in the Cartwright lectures in New York in 1883 an excellent account of the known facts of that day under the title of "The Relation of Microorganisms to Disease." I was fortunate enough to receive instruction in this new bacteriology from Belfield—a course which he gave to a small group of six of us as a private course.

The second man I refer to was Roswell Park, who was at that time an

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assistant professor of surgery under Gunn Park delivered the Mutter lectures on surgery in Philadelphia in 1890 and presented very well the newer conceptions of surgical pathology and especially surgical bacteriology. Park did not remain with us very long. On Gunn's recommendation he was called to the chair of surgery at the Buffalo Medical School where he became, as you all know, one of our great surgical teachers.

In my medical course I majored in anatomy. For three years I was prosector to Professor Chas. T. Parkes, who was a fine anatomist and a brilliant surgeon. Parkes early took up antiseptic surgery and mastered the technic so thoroughly that he obtained excellent results. In 1884 and 1885 he did a series of experiments on forty dogs producing gunshot and penetrating wounds of the abdomen after the dogs had been etherized and prepared antiseptically for a surgical operation. He operated at once, opened the abdomen, controlled the bleeding, repaired the injury of the stomach and intestines and other viscera and succeeded in saving about 50 per cent of the cases. He presented this work as the Chairman's Address of the Surgical Section of the American Medical Association in 1885. His paper attracted wide attention all over the world and was followed at once by many successful operations for penetrating wounds of the abdomen in this country, England and the Continent. Parkes' work was timely. It was made possible by the combination of antiseptic surgery and anæsthesia and improved surgical technic.

The period from 1880 to 1890 proved to be in surgery one of great activity and marvelous development. It witnessed the development of the operations for radical cure of hernia, resection of the stomach for carcinoma, gastroenterostomy for the relief of pyloric obstruction, cholecystectomy and choledochotomy, the removal of kidney stone, the discovery of appendicitis, the operation of appendectomy and new operative procedures in almost every anatomical field made possible for the first time in the history of the world by the fortunate combination of anæsthesia and antisepsis. It was, of course, as the senior members of the association can testify, a wonderful opportunity to live through this period of the development of modern scientific surgery.

After I was graduated I entered the U. S. Marine Hospital service and was stationed for a time in Portland, Oregon. While there I did the modern operation for radical cure of hernia, first, the Czerny and later the Bassini operation, cholecystotomy and cholecystectomy for gall-stone disease, gastroenterostomy, nephropexy and nephrectomy, and later after McBurney's report early appendectomy and removal of the inflamed appendix before an abscess had formed, resection of the second division of the fifth nerve with Meckel's ganglion. These were among the early operations of this kind done on the Pacific coast.

In 1888, after Gunn's death, Charles Parkes was made Professor of Surgery and I was called back to Rush as Professor of Anatomy. At that time the chair of anatomy was often the stepping stone to the chair of surgery.



I felt my deficiencies, especially in histology and embryology, pathology and bacteriology, and planned a post-graduate course abroad in these subjects and in surgery. I did this in 1892 and 1893. I went first to the old Cohnheim laboratory at Leipzig, then in charge of Birsch Hirschfeld (Schmorl was at that time his first assistant). Carl Ludwig was the Professor of Physiology. The great embryologist, His, was then Professor of Anatomy, and I had a very satisfactory course in anatomy under Spalteholz, who was one of his assistants. Thiersch was the Professor of Surgery. From Leipzig I went to Vienna and entered as a student in Billroth's clinic. Eiselsberg was Billroth's first assistant and gave us a fine course in operative surgery on the cadaver.

Billroth was a great teacher. One who attended his clinic could well understand why he had developed so many great surgeons and had filled so many of the surgical chairs of Germany, Austria and Switzerland with his pupils. I early obtained a copy of his book, *Lehren und Lernen*, and have read it and re-read it many times. Although it was written in 1876 I regard it as one of the soundest and most logical schemes of medical education that has ever been formulated, it will well repay every teacher of medicine and surgery to study it thoroughly. It was translated and published in English in 1924 with an interesting introduction by Professor William H. Welch under the title of "The Medical Sciences in the German Universities."

In teaching surgery Billroth trained his students in anatomy, physiology and pathology as the basis for his teaching in clinical surgery, his surgical teaching was done in the out-patient dispensary, the hospital and the surgical clinic. His conception was that the student was an apprentice who was to learn by seeing and helping the master and his assistants in the diagnosis and handling of patients. He taught his students surgery as a successful football coach teaches his squad football, by training them in the actual work itself. He would have had very little patience with some of the modern makers of medical curricula, who take the position that the student is to be given a cadaver and a book or a patient and some books and be left to educate himself. His course on principles of surgery, his courses on surgical anatomy and surgical operations on the cadaver, his laboratory course on surgical pathology and his surgical clinic covered thoroughly the ground. He, himself, taught ten hours a week and he made his own surgical clinic the backbone of the surgical course. The professor of surgery in our American medical schools might well adopt Billroth's scheme of organizing his own surgical department.

In looking over the literature of the period when I began the study of medicine, in order to visualize the surgery of this time, I find nothing that compares with a publication of Billroth's in which he reports the work which he did in his surgical clinic at Zurich and his surgical clinic in Vienna from 1860 to 1876 (*Chirurgische Klinik*, Dr. Th. Billroth, Berlin, 1879). In the introduction of this volume I find an incident which will interest the members of the American Surgical Association.

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Billroth says, in his introduction, "One morning while I was giving a clinic on Lymphoma and presenting the subject in a forceful way to the class, I noticed on the upper row of seats in the crowded amphitheater an elderly gentleman with a fine head and stately figure. In the course of my talk our eyes met and we exchanged several times sympathetic glances. At the close of the clinic he came down into the amphitheater and introduced himself as Professor S. D. Gross, of Philadelphia, the most eminent surgeon in the North American republic and one of the most honored citizens of his country. He held out his hand and said, 'You have presented this subject to your students in the most truthful way, in a way that is seldom done.'" Billroth said that he treasured this meeting and this compliment throughout his life.

In this report of his clinical cases, Billroth gives a very interesting account of his efforts to study and improve the treatment of wounds, a subject to which he devoted much time and study. As early as 1874 he published a research on the vegetation forms of *cocco-bacteria septica* and the part which they play in the causation and spread of accidental wound infection, a research on the various methods of antiseptic wound treatment. This is illustrated with plates showing various cocci and streptococci and bacilli. During the sixteen-year period covered in Billroth's report he handled 9,508 cases and had 785 cases of erysipelas and pyæmia and a few cases of tetanus, making about 8 per cent of accidental wound infections. Of 1,076 patients who died 477 died of wound infection.

He operated on seventy-seven cases of breast carcinoma where he removed the mammary gland and the axillary glands, of these seventy-seven cases twenty-four died, three from secondary hæmorrhage, one from pneumothorax on the evening of the operation and ten each from erysipelas and pyæmia. In his report on his amputations, resections and osteotomies of the extremities, he operated on a total of 214 cases, of these 150 recovered and sixty-four died—nine from collapse, three from erysipelas, two from delirium tremens, and fifty from septicopyæmia—a mortality of 29.9 per cent. Billroth reports that up to February, 1879, he had done 140 ovariectomies, of these eighty-three recovered and fifty-seven died (a mortality of 40.71 per cent). With this terrible mortality we wonder how the surgeons of 1880 had the courage to continue to operate. What a marvelous revolution was brought about by Lister! What a change came with the general introduction of sound antiseptic surgery!

This change really occurred throughout the world in the ten-year period from 1880 to 1890. The change began with Pasteur's discovery in 1861 that fermentation and putrefaction were due to microorganisms and to Lister's conception in 1867 that wound infections were due to these same microorganisms. Lister's first attempts were directed to sterilizing everything that came in contact with the wound, even the air. Lister's work remains today the most important discovery in the development of scientific surgery.

In about 1886 the aseptic method began to displace the original antiseptic technic. It became more and more evident that clinical infection meant as a rule contact infection and that air infection was rare. The

spay was given up and disinfection with carbolic acid was displaced by disinfection with heat. This simplified and improved the entire method. Von Bergmann and one of his assistants, Schimmelbusch, contributed a good deal to this new aseptic surgery. Suddenly it seemed almost as if by magic the tragedies and terrible pictures of post-operated deaths from wound infection, such as Billroth reported in 1879, disappeared and a new and wonderful scientific surgery was born. Chas. T. Parkes, who succeeded my old teacher, Gunn, in the chair of surgery, was able to report in 1888 twenty-five laparotomies done before a large class in a huge teaching amphitheater without a wound infection and with only two deaths. In this new development of modern scientific surgery America played an active and creditable part.

*The Teaching of Surgery*—The American Surgical Association, in addition to its scientific work, has a most important function to perform as an Association composed of the teachers of American surgery, a function which I believe it has done and is doing well.

I began my teaching work at Rush in 1888 as professor of anatomy, devoting about half my time to my college work and the rest to surgical work at the Presbyterian Hospital. The next ten years were years of very active development in surgery. In 1898, Rush became a part of the University of Chicago and under the inspiring leadership of President William R. Harper began a reorganization along university lines. We secured Lewellys F. Barker, who was then in the anatomical department with Mall at Johns Hopkins, to take the chair of anatomy, and I was made Associate Professor of Surgery under Senn. In 1900 I became a member of the American Surgical Association. During this period we were studying eagerly the subject of the reorganization of medical education at the University of Chicago. In 1902 I was made Chairman of the Committee on Medical Education of the American Medical Association, and in 1904 we succeeded in having created the Council on Medical Education of the American Medical Association.

In previous years this committee had brought in a formal annual report which was read and published in a routine way but little had been accomplished. Fortunately, we had an active, strong committee which devoted a good deal of study to the problem and we brought in a report advocating the establishment of a more permanent committee, each member to serve for five years. We asked for a salaried secretary and enough funds to carry on an active investigation throughout the year. In 1904 we succeeded in having created a Council on Medical Education of the American Medical Association along these lines. Our committee's investigations had shown the necessity of a national influence and control of medical education and we found that this control could not be exercised by the Federal Government. We, therefore, recommended that the American Medical Association create a Council on Medical Education to exert such national influence and control.

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From 1904 until 1928, when I retired as Chairman of the Council on Medical Education, I devoted a great deal of my time to this work. We formulated a program which aimed to secure in America a pre-medical course of two years in physics, chemistry and biology in the university, four years in the medical school and an internship of at least a year in the hospital. In less than twenty years we succeeded in putting this program into effect. We reduced the number of medical schools from 160 to eighty. We cut the number of medical students in half. We eliminated twenty homeopathic schools and ten eclectic schools by securing the general acceptance of the preliminary requirements of physics, chemistry and biology, and converted almost all of the schools that survived into medical departments of universities.

The reorganization was more thorough and more complete than we had even dared to hope. We secured the cooperation of President Pitchett, of the Carnegie Foundation, and also the cooperation and enormous financial assistance of the Rockefeller Foundation and the General Education Board through President Vincent. We secured the active support of the State Examining Boards and of the Association of American Medical Colleges. The success of the reorganization of medical education in this country was in large part due to the cooperation of these various agencies with the American Medical Association.

Samuel P. Capen, Chancellor of the University of Buffalo, read a paper before the Annual Congress on Medical Education and Licensure, held February 13, 1933, in Chicago, in which he said, "No other phase of American education has ever been so drastically reformed in so short a time as was medical education. In 1904 the vast majority of medical schools were, with respect to requirements for entrance and instructional procedure, scarcely above the level of trade schools. By 1918 medical education had been generally transformed into a university enterprise, on the whole the most consistently excellent enterprise that the universities conducted. The Council on Medical Education reformed not medical education alone, through the influence of its example it has brought about the general reform of professional education."

In this work of the reorganization of medical education the members of the American Surgical Association gave generously of their support, many of them took an active part in the work, notably Frazier and Haggard, who were for some time members of the Council, and Fred Lund, Harvey Cushing, John Finney, William J. Mayo, Dudley Allen, Joseph Blake, Herbert Burrell, Frederic Geerish, William S. Halsted, Rudolph Matas, Lewis McMurtry, William Rodman and Herry Sherman, who served on various committees and formulated the organization of surgical teaching.

*The American Surgical Association*—The membership of the American Surgical Association is at present limited to 150. This year there was but one vacancy created by the death of an active member. The officers

of the Association succeeded in persuading nine active members to change their status to senior members. Is it fair to ask comparatively young members to do this? The United States and Canada are steadily increasing in population. The number of unusually competent surgeons, men who from every standpoint are entitled to membership in our Association, is increasing very rapidly from year to year. Would it not be well to make some provision at this time for a gradual increase in our membership? I would suggest that in addition to filling the vacancies that occur each year, we add for the next five years five new men each year. This plan would in five years increase our membership to 175, a number which is quite safely within the limits of our conception of a strong representative surgical association, representing both this country and Canada. I hope that the Association will look favorably into the matter of such gradual increase and take the necessary action to bring it about. I believe that such a step will strengthen our Association.

Gradually in the last fifty years the practice of medicine has become more and more divided into *specialties*. I have already referred to the fact that the founder of our Association, Samuel D. Gross, stated in 1876 that "it is safe to say that there is not a medical man on this continent who devotes himself exclusively to the practice of surgery and that American medical men are general practitioners and cover the entire field of medicine, surgery and obstetrics." This condition has been greatly changed. There are today in the United States about 160,000 practitioners of medicine. The Register published by the American Medical Association gives the age of the physician, year and school of medicine from which the medical degree was received and the state granting the license to practice medicine, and also states whether the physician specializes in any specialty and whether he limits his work to that specialty. Of these 160,000 physicians 47,390 state that they are specializing in some special field and 24,391 state that they limit their practice entirely to that special field. You may be interested to know that in surgery 3,998 men limit their practice to general surgery, and that 8,550 devote special attention to surgery, 200 men limit themselves to industrial surgery and 734 devote special attention to industrial surgery, 604 men limit their practice to orthopædic surgery and 281 devote special attention to orthopædics, 190 limit their practice to proctology and 346 devote special attention to it, 1,326 men limit their work to urology and 1,024 specialize in it, a total of 17,253 limit or specialize in general surgery, industrial, and orthopædic surgery and proctology and urology.

There can be no doubt but that medicine has been advanced by men who have specialized in limited fields, and the right sort of specialism and the right sort of specialists should be encouraged and maintained. On the other hand, half-baked specialists and commercial specialism are a definite menace to both the profession and the public. This problem is not new. In an address on specialism in 1892 Osler said, "No more dangerous members of our profession exist than those born into it, so to speak, as specialists." It

requires fully as much or more intelligence and training to become a competent practitioner in general medicine or general surgery as it does to become a specialist. There is a growing demand on the part of the public for specialists in medicine, and many medical men go into specialties because of this fact—because it pays. Many of our 47,000 specialists in this country have not had the training and experience that would warrant their posing as specialists.

This has presented a difficult problem to solve. A man who is licensed by a state to practice medicine can, of course, cover the entire field of medicine, and this right should not be restricted in any way. There should be, however, some means found to protect the public against illy prepared specialists, or at least an effort made to designate in some way properly trained specialists. The minimum requirements for the training of a specialist can probably be agreed upon as graduation from an accredited medical school, at least one year as an interne in an accredited hospital and then several years in general practice of medicine or surgery and at least three years' training in the specialty in an accepted hospital and under the instruction of a recognized specialist, a Master's Degree might be granted for such work well done. This degree, however, would probably not go very far in solving the problem or at least not far enough. To my mind the most effective way would be to call to our aid the concerted action of our better hospitals. More and more the well-organized and well-conducted hospitals are becoming the centers of the medical activities of our communities. Most specialists need good hospital facilities to carry on their work. If we could succeed in having the American Hospital Association and the American Medical Association act in this matter and secure the united action of the organized medical profession and all of our best hospitals in demanding the proper training for all the men appointed as attending men on their hospital staffs and demand a minimum of three years of special training for men posing as specialties, it would go far toward protecting the public, the profession and the hospitals and eliminate much unnecessary work and work done by incompetent men. Within the last twenty-five years, and especially since the war, there has been a tendency to split general surgery into many specialties.

The *scope of the field to be covered* by the American Surgical Association has never until comparatively recently been a matter of question. Since the founding of the Association in 1880, it has always been the purpose of the organization to cover the entire field of general surgery. In the last twenty years there has been a tendency to split off first one and then another and another anatomical region and develop it into a surgical specialty. This has been due, in part at least, to the development of some new instrument of diagnosis, such as the laryngoscope, the cystoscope, the proctoscope or some new procedure in management as plaster-of-Paris fixation in orthopaedic cases, or X-ray and radium in the treatment of malignant disease and other lesions. In some instances, as in neurosurgery, it has been due to the

special preparation in diagnosis and the special operative technic required in the development of a new and difficult field. We all, of course, welcome these new instruments and methods for they have increased our knowledge and power.

There is, however, an unfortunate side to this problem. The special technical training involved in these new instruments and methods has led to the development of specialties and specialists and a tendency to separate these fields entirely from general surgery and to the training of young men in these limited fields without receiving first a broad general surgical training. The first men who developed these surgical specialties were general surgeons with a broad surgical training which made them safe men to handle this special work and other conditions involving other parts of the human body which often have to be recognized and dealt with in the proper treatment of the individual case. In some of these surgical specialties today young men frequently go direct from the medical school, or after a short hospital internship, into some surgical specialty which involves a narrow field, a single organ or a group of organs. This is not the best organization of surgery and surgical teaching. We should insist upon a broad training in general surgery as a prerequisite to entering a surgical specialty.

Another phase of this question must interest us as members of the American Surgical Association. Gradually as these surgical specialties have developed and special societies in these subjects have been formed, there has been a tendency to cut off entirely from general surgery these special fields. This has already been carried very far. What would become of general surgery if the head, spine and peripheral nerves were lopped off by the neuro-surgeons, if the specialists in thoracic surgery took over the chest, if urologists took over the genito-urinary organs, proctologists the rectum and colon, orthopaedic surgeons fractures and dislocations and the extremities and plastic and oral surgeons appropriated their own special field? The gynecologists and obstetricians have for a long time claimed the female genito-urinary tract as exclusively their own. This would leave to general surgery nothing except that small part of the body between the diaphragm and the umbilicus, and now comes another claimant into the field, the tumor specialist or the cancer specialist. I have no hesitation in denouncing this last as a very serious blunder. We might just as well develop specialists in inflammation of all parts of the body as to train men as specialists in cancer involving all parts of the body. Within the last year I have met several of these men who pose as being specialists in the recognition and surgical treatment of malignant disease, no matter in what anatomical region it occurs. Of course, any man who is licensed to practice medicine has the right to devote himself to any field he desires.

Let us look at this subject from the interests of the great science of surgery, of the American Surgical Association and the interest of the public. If we do this I am confident that we shall all agree that surgery must remain intact as a great science covering the entire body, and that the Ameri-

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can Surgical Association in its work in its programs should cover the entire field of general surgery. Much of the best work done in these special fields in brain work, in bone and joint work, in genito-urinary surgery, in thoracic surgery, in plastic surgery, has been done by members of the American Surgical Association, and many of the leaders in these fields are here with us today. We should maintain this leadership. We should welcome as members groups of outstanding men who have developed in these various special fields. We welcome the advances made by intensive study of special surgical fields but in the interest of the future of both general surgery and the surgical specialties, general surgery must be kept intact and broad enough to cover the entire subject and it must continue to act as the great teacher, the great stabilizer of all fields of surgery. In the teaching hospitals in the university medical departments and in the group clinics it is clearly right and proper, and to the best interests of the science of surgery that men well-trained in general surgery should devote themselves to special surgical fields, but the bulk of the surgery of the country will continue to be done, and will be well done, by surgeons who have been trained in general surgery and who practice general surgery, and a thorough training in general surgery will continue to form the basis of the training of both general surgeons and surgical specialists. This subject presented itself as an acute issue during the World War. While working in the Surgeon General's office in Washington I was requested by General Gorgas to make a study and report on the relations of general surgery to the surgical specialties. I later read a paper covering this ground at the meeting of the American Surgical Association in Cincinnati in 1918, and this was published in vol xxxvi of the Transactions under the title, "Coordination of General Surgery and the Surgical Specialties."

The American Surgical Association is composed largely of teachers of surgery. In addition to our interests in the science and art of surgery, the American Surgical Association has other important *functions to perform*. We must teach our young men the importance of accepting a code of ethics, a code of morals, which will insure the highest character to all their actions in their surgical work. We must teach them to develop a judicial attitude. As surgeons they are often the court of last resort, we are called upon to decide questions which involve the life and the health of the patient. These questions must be answered in the safest, most logical, most judicial and the most scientific way. We must teach them that there is an art of surgery which they must master. We must teach them that one of the most important things in the practice of surgery is the practice of common sense.

We can all be proud of the great developments that have been made in surgery since the founding of the American Surgical Association in 1880. We are proud of the contributions made to this wonderful development by members of our Association. I have sketched for you hastily the story which the swiftly moving finger of time has written in the last fifty years. We have accomplished much but we are but at the beginning of our task.



The mighty future holds for the science of medicine, for the science of surgery the greatest possibilities of development, the greatest possibilities of good. The men of our generation will pass on the torch to younger and stronger hands. They can feel, however, as one by one they fall out of the ranks, that they have served the science of surgery and their country well and they cannot find fault with the fates for they have been most fortunate, they have had great opportunities, they have lived in the most productive period of medical history. As we grow older we find that there are compensations which come with the marching years.

There is beauty in the sunset, a golden coloring in the autumn. A wider vision comes, a kindlier feeling toward the comrades who are marching with us along the same road, a great joy, a great pride in the young men we have trained, a keener appreciation of life with all its possibilities, a greater joy in living. We learn to overlook and forget the little things that once irritated and annoyed us. We learn that no one can injure us but ourselves. We learn the simple and wonderful lesson of the Golden Rule. We learn to recognize and bow down before the immutable laws of the universe. We are but atoms in a mighty scheme, but small as we are we are a part of it, and whether we will or not the good and the bad of our lives will live on. Scientists as we are, we learn from science the laws of life, the laws that men must follow for their own good. We learn that the physical law and the moral law are one. Define these as you will, such knowledge means a religion. Let us make a confession of faith in life in science in the future, in our fellow men.

## UNDESCENDED TESTICLE

A COMPARISON OF THE END-RESULTS OF TOREK'S OPERATION AS CONTRASTED  
WITH THE FORMER METHODS OF OPERATION

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IN 1926, we reviewed the operations for undescended testes at the Ruptured and Crippled Hospital and were so discouraged with our end-results that we sought some better method of operating. Torek's results by orchiopexy, bringing the testis out through an incision in the scrotum, anchoring it to the fascia of the thigh, and suturing the margins of the scrotal wound with those of the thigh, were so satisfactory that we tried his method, first in selected cases, and being so pleased with the results have adopted it as the routine procedure during the past five years both at the Ruptured and Crippled Hospital, The Children's Surgical Service at Bellevue Hospital and at the Lincoln Hospital.

Torek first published "The Technique of Orchiopexy" in 1909, and Meyer, in 1927, reported on sixty-four cases which had been performed by Doctor Torek and his associates up to that time. Their results were all satisfactory, a record which we unfortunately cannot equal, but as our patients have been operated upon by a fairly large staff at each hospital the results may more nearly represent what the average surgeon may expect to accomplish. No other clinic has reported any considerable number of cases and we firmly believe this operation should become more popular than it is today. We have not infrequently operated upon cases by the older method in which we felt at the time that the cord had been sufficiently lengthened to permit the testis to lie free in the bottom of the scrotum. However we learned that it frequently retracted even as high as the external ring. We agree with Torek that the stretching and development of the scrotum is the factor that prevents retraction of the testis when the cord has seemed of sufficient length.

*Age of Operation*—We still believe, as stated in our previous article, that the most suitable age for operation is between eight and twelve years. This gives the testis a good chance to descend voluntarily if it will, it is larger and easier to manipulate and the structures are more easily identified than in younger patients. Also the organ has been placed in its normal position before the changes which come with puberty occur. If the undescended or mal-descended testis is accompanied by a large hernia, we feel an earlier operation is imperative as natural retention of the hernia by a truss is sure to exert pressure on an already underdeveloped organ and would also prevent any tendency to normal descent. Moreover, the continued trauma of a truss may theoretically at least predispose to malignant change in the

undescended testis which statistics have shown is of itself more prone to such degeneration than the testis normally situated. Thus treatment is therefore contraindicated. In mal-descent, especially when the testis is directed into the thigh instead of the scrotum, we usually advise operation earlier as further descent does not aid the testis in reaching the scrotum.

*Operative Technic*—The usual incision as for an inguinal hernia is employed. In carrying this incision through the superficial fascia it is important to realize that we may be dealing with a sac of the superficial inguinal type which after its emergence from the external ring turns upward toward the anterior superior spine and lies on the aponeurosis of the external oblique just beneath the deep layer of the superficial fascia. If this possibility is not borne in mind a hasty incision may result in damage to the testis or vas. In cases where the testis has never escaped through the external ring this latter may be very small and difficult to identify. Rather than spend too much time in trying to identify it we believe it is simpler to make an incision in the aponeurosis of the external oblique from above downward, terminating immediately over the spine, which is the point where the external ring is located. Having reflected the aponeurosis and exposed the inguinal canal the cremaster is split in the direction of its fibres and the sac, vessels and testis delivered, the vessels and testis lying apparently within the sac. The latter is now opened near the internal ring but sufficiently distant from it so that in case the sac is torn during the separation of the vessels it will be readily recognized before the tear has extended within the ring. By making gentle traction on the testis, either by means of a clamp attached to the gubernaculum or by surrounding it with gauze, the sac and vessels are put slightly on the stretch. This tension brings out the natural cleavage planes between the sac and the vas and vessels which are spread out on the posterior surface of the sac. Clamps are placed on either side of the opening in the sac and the vessels and vas are separated from it by displacing them posteriorly, working with blunt-pointed scissors in the areolar tissue which lies between the sac and infundibuliform layer of fascia, the latter uniting the cord structures to the sac. Having cut across the sac the next and most important step is the separation of the upper end from the vessels. This procedure is simplified by putting a blunt retractor within the internal ring and lifting it upward, thereby facilitating a higher separation and breaking up all the adhesions between the vessels and the peritoneum anteriorly and the abdominal wall posteriorly. The sac is now transfixed and ligated and the redundancy excised. This procedure cures the hernia. The lower end of the hernial sac is excised close to the testis and all fascial bands between the internal ring and the testis including the gubernaculum are removed so that the vas and the vessels of the cord are denuded of their coverings. Doctor Torek especially emphasizes this step and we think some of our failures may have been due to lack of thoroughness in this procedure.

If the vessels are still too short, division of the spermatic artery and vein as recommended by Bevan are to be considered, but in both Doctor Torek's and our own experience this has not been necessary. Most surgeons who have divided the vessels and have followed their patients have been impressed by the fact that the testes usually atrophy and may even disappear entirely (Figs 1 and 2).

An oblique incision about one inch and a half long is now made on the inner surface of the thigh at a site where the testis lies without undue tension and the fascia lata exposed, care being taken not to injure the internal saphenous vein. Torek recommends that this incision should be made from in front backward and slightly downward so that the apposition of the scrotum and thigh is a more natural one and the tension is slight and evenly distributed along the entire suture line. A pocket is now made in the bottom of the scrotum which is distended with gauze and incised, the incision corresponding in length and direction with that of the thigh. That the inner limit of this incision should be the median raphe. The posterior lips of the two incisions

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are now sutured together Torek advises using interrupted sutures of catgut and states that this step is the most difficult in the entire operation due to the difficulty of preventing inversion of the two skin surfaces We feel that we have simplified this step in inserting temporary traction sutures at the two angles and using a continuous suture of



FIG 1

FIG 2

FIG 1—Two months after first stage Testis in scrotum

FIG 2—Double undescended testes Anastomosis made too low on right Testis buried in thigh and difficult to palpate

a subcuticular type A firm bite is obtained in the subcutaneous tissue but the skin is transfixed as in a subcuticular stitch which avoids the complication of inversion and favors approximation of the two skin surfaces After the posterior margins have been sutured the traction sutures are removed The testis is now brought down through the



FIG 3

FIG 4

FIG 3 —Second stage right, first stage left When the right testis was delivered from thigh it was found to be normal in size

FIG 4 —Left undescended testis One year after second stage

scrotal wound and sutured with two or three interrupted chromic sutures to the fascia of the thigh, enough of the tunica albuginea being picked up to give a good hold The anterior margins of the thigh and scrotal wounds are sutured with a continuous silk suture, care being taken to get good approximation especially at the angles The inguinal hernia is repaired in the usual manner without transplanting the cord A strip

of vaseline gauze is passed through the canal of skin between the scrotum and the thigh which serves as a dressing for the deep sutures

While Torek does not recommend it, we feel more secure if the knees are strapped together to prevent tension on the suture line

The skin of the scrotum and thigh are quite different in character and in our experience union does not take place as promptly as in a simple incision, consequently we do not remove the sutures until the ninth or tenth day. Frequently we do not have perfect approximation at the angles and there may be a small granulating wound at these sites which heals in a few days. The patient is usually out of bed on the twelfth day and discharged at the end of two weeks

We agree with Torek that the post-operative course is uneventful. These individuals are perfectly comfortable, are able to indulge in all activities which a normal person might and do not complain of any drag on the scrotum or suffer from eczema

The second stage releasing the testis from the thigh is indicated as soon as the scrotum has stretched out to near the normal size, which is usually from two to three

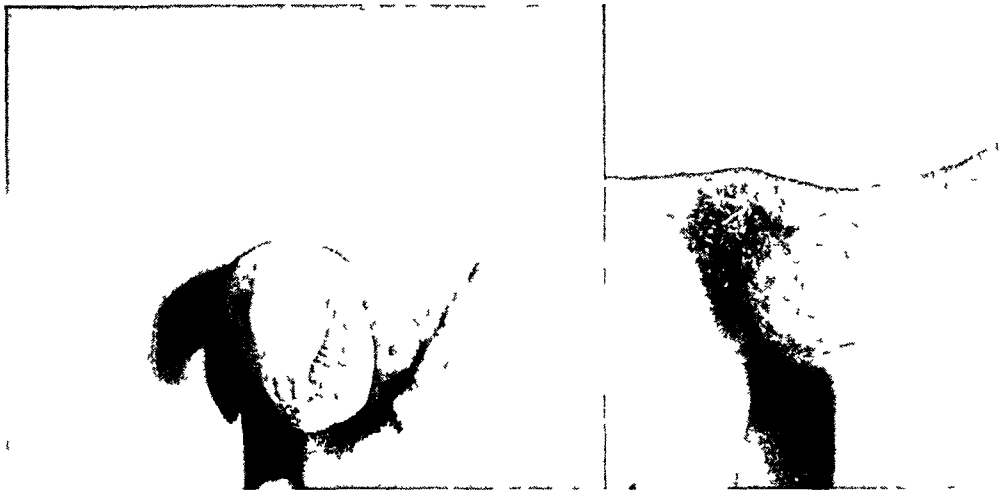


FIG 5

FIG 6

FIG 5—Operation six years ago by former method. Left testis at external ring. On right side vessels divided and testis atrophied. Result after Torek on left side one year ago. Testis in bottom of scrotum and normal in size.  
FIG 6—Double undescended testes. Result three years later. Operation in three stages. Normal sized testes in bottom of scrotum.

months. If this is not a convenient time, as is frequently the case in school children, we put off the second stage until the summer vacation or some other suitable period. A boy sixteen let three years elapse between his first and second stages. During this time he led a normal life and entered into all the school activities which he would have if his testis lay in its normal position. (Figs 3 and 4)

Separating the testis from the thigh is a rather delicate operation and care must be taken not to incise or injure the organ. We recall one instance in which, to be sure we had sufficient skin to cover the testis, we removed some of the skin of the thigh and sutured it over the testis. This thigh skin promptly sloughed—why, we cannot say—but since then we have been careful to make our incision through the skin of the scrotum and have not had any difficulty in covering the testis without tension. The sutures are removed in a week and the patient discharged on the same day. (Figs 5 and 6)

In patients with bi-lateral undescended testes our usual procedure is to bring the testes down one at a time. At the second operation the first testis is released and the second brought down, the latter being released at the third operation. While Torek advised against bringing them down at the same time due to the increase in tension between the scrotum and the thighs one of us (Coley) in three cases has performed the

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double operation in two stages with satisfactory results As a routine procedure we feel the three-stage operation is probably safer

*Results*—In our previous article the results as regards location of the testis were about 50 per cent satisfactory These included nearly a third which were in the upper scrotum, which we would now consider, a position unsatisfactory Our percentage of normal sized testes was about 15 per cent (Figs 7 and 8)

Charles Mixer reported in 1924 a series of 207 cases in which the end-results were noted in sixty-one His percentage of good results both as to location and size of testis were 79 per cent satisfactory These statistics are distinctly better than ours, but are based on only 30 per cent of his total operations



FIG 7



FIG 8

FIG 7—Double undescended testes Both sutured to thigh at first stage  
FIG 8—Both testes released at second stage Result two months later

Bevan in his last article does not give his percentage and we are not familiar with any other larger series of end-results

In reviewing our Torek operations we are impressed with the fact that many times a testis which was only one-half or two-thirds normal in size at the first operation has developed in the thigh, and at the second stage approximates the normal Others that are not normal at this stage continue to develop in the scrotum and a follow-up note a year later states that the operated testis is the same size as its fellow Not infrequently a testis buried in the thigh is difficult to palpate and its actual size cannot be appreciated In several instances where we thought it was greatly atrophied, we have been agreeably surprised to find, after dissecting the organ from its bed in the thigh, that it had developed to normal proportions

There may be some slight delay in healing at the angles of the wound due to faulty skin approximation This seldom causes trouble, but if an infec-

tion supervenes the scrotum takes longer to stretch out because of the scar tissue and it is wiser to wait a longer period before advising the second stage. If attempted before the scrotum has stretched sufficiently it may be difficult to cover the testis due to a deficiency of scrotal skin. After the first stage the testis usually lies in the thigh, but may pull away and remain in the lower scrotum, either position gives as satisfactory final result.

We have previously stated that these children are perfectly comfortable, between the first and second stages, but we must report one catastrophe which happened to a child of fourteen, who lived in an adjacent city. He was awaiting the second stage and his physician reported that while playing in the street he suddenly experienced pain in the left inguinal region. This continued for several days when he was operated upon and an early gangrenous testis removed. Torsion of the cord would seem to be impossible with the testis anchored in the thigh and it is difficult to understand how trauma could have caused sufficient disturbance to the circulation to permit gangrene. We are at a loss to explain the etiology.

We have 137 completed cases for a final analysis. In 123 the results are excellent, the testis is normal in size and lies free in the bottom of the scrotum. In fact, the scars in the groin and thigh are the only evidences of a previously undescended testis.

Our failures were due to technical errors, sufficient care was not used in dividing all the fascial bands or the vessels were not sufficiently mobilized to permit the testis to be sutured to the thigh without tension. In a few cases the scrotum was sutured to the thigh in a position which caused too much tension on the suture line so that the scrotum partly or completely separated from the thigh.

Five testes sloughed, two of these were sutured to the thigh without tension but the suture line became infected and the scrotum separated completely from the thigh. This separation plus the infection undoubtedly caused the sloughing. The other three were sutured to the thigh under too much tension.

Nine are reported as atrophic, in three the atrophy was complete. One patient was discharged with a testis nearly normal in size but a follow-up note one year later stated that the testis had atrophied and could not be palpated. This is our only record of a case of atrophy in a testis approximately normal in size. The others varied from one-third to one-half normal. We attribute this atrophy to interference with the blood supply from too much tension on the vessels. In no case were the vessels of the cord deliberately sacrificed.

*Conclusions*—Failures by Torek's method of orchiopexy can usually be attributed to some technical error. The end-results in our hands are so far superior to those which we obtained by the former methods that we do not feel justified in using any other type of operation.

*DISCUSSION*—DR BRADLEY L. COLEY (New York) said that any discussion of the surgical treatment of undescended testis should be prefaced by a word of appreciation of

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the pioneer work done in this field by Doctor Bevan. His operation will stand as the classical procedure for this condition, comparable to that of Bassini in inguinal hernia.

About twenty-five years ago Doctor Torek devised the operation to which his name is attached. For a number of years the operation was not widely used, but about six years ago Dr. Herbert Meyer reported on some sixty-five cases.

When one operates upon a case of undescended testis, in the majority of cases one is able, by carrying out the steps as outlined by Doctor Bevan, to elongate the cord sufficiently to be able to place it in the scrotum without undue tension. A small percentage of cases are found in which it becomes necessary to decide whether to divide the vessels in order to gain sufficient length or to abandon the operation. Dividing the vessels does definitely increase the likelihood of atrophy. There are plenty of examples in which atrophy did not take place if due care was taken not to injure the vessel that goes with the vas, but this division should be reserved for those cases where it is impossible to get length otherwise. Very rarely one finds a case in which, after the most careful dissection, the testis and the vas are too short to permit of sufficient elongation to place the testicle in the scrotum. In such a case it becomes a choice of doing a removal of the testis or replacing within the internal abdominal ring. In this very rare instance, if the case is a unilateral one, it is probably best to remove the organ. In most cases it is quite undeveloped. If the case be one of bi-lateral undescended testicle it is best not to remove it.

Some interesting work had been done by Moore on the temperature influence in the development of the spermatogenic function of the testicle. His experimental work on animals would lead to the assumption that one should make an effort to replace the testes in their physiological position in the scrotum before puberty. At what age it should be done is still a much debated question. His own judgment is that it should be done between the ages of eight and twelve, other factors being equal. If a troublesome hernia exists, it cannot be handled with a truss because of the associated undescended testis, and the operation should be done at an early period.

One point in the technic of the Torek operation worth emphasis is the hazard of placing the incision in the thigh in such a way that, when sutured to the scrotum, there is tension on the suture line. He had seen several of these cases where the separation of the suture line took place, which usually results in a slough of the testicle. The peculiarity of the scrotal skin seems to make a difference in the healing of the skin of the thigh. It does not heal with the same rapidity and firmness and in the same length of time.

There is one type of undescended testis in which operation should be advised only after the doubtful outcome is carefully explained to the parents, *viz.*, that form of dyspituitarism known as Frohlich's syndrome. He had seen a number of these fat boys with bilateral ectopia, and he felt that the operation did not influence the general development and endocrine status of the child insofar as he had been able to determine.

DR F N G STARR (Toronto, Canada) showed two lantern slides, and said that after the cord had been freed he took a silver wire as shown in the slide and sutured the tunica of the testicle to it. Then the testicle, after the scrotum had been stretched, was put down to the bottom of the scrotum. The two wires were brought out of a nick at the bottom, turning each transversely, two horsehair stitches caught it there and then a loop at the other end was sutured by a fine catgut to the periosteum in the os pubis. The results had been extraordinarily good.

DR J SHELTON HORSLEY (Richmond, Virginia) said that in two cases after separating the cord and mobilizing the testicle as much as possible, he placed a loop of non-absorbable suture, either silk or silkworm gut, in the bottom of the testicle, catching a firm hold. This was not tied but was brought through the bottom of the scrotum. The loop was then tied and fastened to a small rubber band, which was tied to a linen thread and the thread fixed by adhesive to the thigh, making traction on the testicle.



The procedure was such a simple thing that he was quite sure it was not original, although he had not looked up the literature. However, he thought it involved some rather common principles in plastic and other types of surgery in which gradual and gentle traction continued for a long period will often correct the position of misplaced structure. This suture on the testicle will hold a week or longer, depending upon how strong the traction is. The traction should be slight but constant. It will bring the testicle well down and then the suture can be removed without any trouble.

DR FRANK S. MATHEWS (New York City) said it is remarkable how many body processes are initiated or modified by the hormones of the pituitary gland. Every one interested in the mechanism of cryptorchidism should be interested in the experiments by Doctor Engel, of New York, published in a recent *Journal of Endocrinology*. He worked upon Macaque monkeys in which the testes at birth are in the upper end of the inguinal canal and which make their descent in the course of the next few years. By injections of anterior pituitary hormones he has been able to cause the testes to descend to the bottom of the scrotum within a month. It was an interesting observation that the scrotum elongates and descends conspicuously before the descent of the testis was observed. It is his belief that in the bilateral cryptorchidism in man the fault lies in the pituitary. When the condition is unilateral it is not unlikely that a mechanical cause is responsible.

Doctor Mathews had never done the Torek operation but has confined himself to the methods which depend upon freeing and elongation of the cord as much as possible. At the termination of the operation the result has often seemed satisfactory but when the patient is examined in a year or two there is disappointment. When sutures have been passed from the testis through the bottom of the scrotum and are then anchored to the thigh it has seemed as though the results should be improved, but the sutures soon cut out and, irrespective of the method used, can be depended upon only for about a week. He has wondered whether the results of the Torek operation were not due to the fact that the testis is removed from the upward pull of the scrotum during the time that it is attached to the thigh. When all the structures of the cord have been divided except the vas and vessels, it does not seem as if the cord could be responsible for the elevation of testis but rather a contraction of the scrotum.

Every one interested in this subject should read the work of Moore on the function of the scrotum, published several years ago. From his work it would seem unlikely that the transplantation of the testis into the scrotum after adolescence could possibly result in bringing about spermatogenesis in the organ. Conditions, however, are quite different when the operation concerns younger children.

DR HENRY H. M. LYLE (New York City) said that four years ago in discussing Doctor Bevan's paper at Cleveland he called attention to the fact that the pull to which the testicle is subjected in the Torek operation seemed to have a stimulating effect on the opposite testicle. He cited a personal case of double undescended testicle in which during the first stage of the Torek operation the opposite testicle descended into the scrotum. Since then he had observed this phenomenon in two additional cases.

Regarding the applicability of this operation to the abdominal testicle one of his assistants has successfully transplanted such a testicle to the bottom of the scrotum in three stages. In the first stage the testicle was brought to the pubis, in the second to the thigh and finally, to the bottom of the scrotum. In this position the testicle has developed and appears to be a normal organ.

DR WILLIAM B. COLEY (New York City) said that of 80,736 cases of inguinal hernia in the male observed at the Hospital for Ruptured and Crippled, he found 1,357, or 1.65 per cent, associated with undescended or mal-descended testicle. From 1890 to 1918, 4,453 cases of inguinal hernia in the male had been operated upon, of which 334, or 7.5 per cent, were associated with undescended testicle. The majority of these

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cases occurred in children under the age of fourteen, inasmuch as in the earlier days adult hernia patients were not admitted to the hospital

As regards the undescended testis in adults, of 1,040 cases of hernia operated upon at the Memorial Hospital by Dr William A Downes and himself, forty-nine, or 4.71 per cent, were associated with undescended testis

The method of operation adopted by Dr William T Bull and the speaker in 1892 and 1893 was, practically, the Bassini operation. They, however, omitted the step of transplanting the cord, thus adding a half-inch or more to the length of the cord. In addition, the cord was freed as high up as possible and the bands of fascia, which usually made it possible to place the testis in the bottom of the scrotum, were divided. At about the same time, and quite independent, Bevan developed his operation on the undescended testis, which embodied the principles just described and had several additional features which were improvements over their method. One of these was the purse-string suture of the tissues just outside the external ring which prevented the testis from retracting into the canal or above the external oblique. The second feature of Bevan's operation was the removal of a part or nearly all of the veins of the cord. This naturally added to the length of the cord and to the ability to place it at the bottom of the scrotum without much tension. Bevan himself restricted the excision of the veins to very difficult cases and did not use it as a routine operation.

In April, 1908, Doctor Coley reported 126 cases of undescended testis personally operated upon and traced as far as possible to end-results. Ten years later before the Southern Surgical Association (Surg, Gynec, and Obstet, May, 1919) he reported 365 cases of undescended testis operated upon at the Hospital for Ruptured and Crippled to which were added fifty cases in adults operated upon by Doctor Downes and himself at other hospitals, making a total of 415 cases, seventy-seven were of the inguino-superficial variety and eight of the inguino-perineal type, 149 cases were traced from one to twenty years.

While their results were, in their opinion, reasonably satisfactory, they were not absolutely ideal, since in a considerable number of cases the testis retracted to the region of the external ring. There was no case of death or of recurrence of the hernia in the entire series. When Keating of England brought out his operation for undescended testis, the principal step of which consisted in burying the testis for a short period in the thigh at a level with the scrotum, Doctor Coley was not at all impressed with it. A few years later Torek brought out his operation. While this seemed markedly superior to Keating's, Doctor Coley was still unconvinced that it was sufficiently superior to Bevan's method or to the one employed at the Hospital for Ruptured and Crippled to warrant its substitution. It was not until 1927 when Dr Herbert Willy Meyer read a paper at the New York Surgical Society on the Torek method and presented a large series of end-results which were more satisfactory than any Doctor Coley had observed from the older methods, that he was finally convinced of the superiority of the Torek operation. Soon after, Doctor Burdick and Dr Bradley L. Coley began performing the Torek operation at the Hospital for Ruptured and Crippled, with the results which have just been presented.

In attempting to review the whole question in a judicial way it seemed to him that it might be better to admit that the results obtained by the Torek operation are more satisfactory than those obtained by the older methods. At the same time he would reserve the Torek operation for the group of more difficult cases in which it is almost impossible to place the testis in the bottom of the scrotum without great tension, and would continue to treat the larger group of less difficult cases by the Bevan operation which has proved so highly satisfactory in the majority of cases.

Regarding the proper age for operating on the undescended testis there is still considerable difference of opinion. Many years ago he adopted the plan of waiting until the patient had reached the age of ten or twelve years before operating unless there was some special reason for an earlier operation, in the way of a hernia which was not

easily controlled. He still follows this plan although some advise operating as young as from five to six years. His principal objection to an earlier operation is based on the fact that in a considerable number of cases the testis has descended of its own accord as the child approached puberty.

Some surgeons advocate the removal of the undescended testis on the ground that it is of no special value. While most writers regard it of no functional value, there is no question but that the interstitial elements of the testis have an important bearing on the development of the male characteristics of the child, and for that reason he believes the testis should not be sacrificed. It is by no means true that the undescended testis is always functionless. He had two patients with double undescended testes who married and had children.

DR CARL EGGERS (New York City) said that as a pupil of Doctor Torek he early started in to use the method which he has described. In his hospital service it is used to the exclusion of others in all patients admitted for the purpose of having the position of the undescended testicle corrected. Some patients come in for the repair of an associated hernia rather than for the undescended testicle. At times one has to make a distinction between the two, especially in adults, because some are more interested in having the hernia repaired than they are in the position of the testicles, and they do not wish to have two operations performed.

With children, particularly, it is a question of both. The mother of the child is not interested in the hernia alone. She wants her boy to be a normal boy. When one follows results of other methods and sees that after awhile the testicle has shrunk or has retracted to a position where it produces pain and discomfort and is unsightly then it becomes apparent that a method which will give a normal-appearing scrotum and testicles and at the same time relieve the hernia is the one to be adopted.

Other methods of traction have the disadvantage that they leave a canal at the bottom of the scrotum through which infection may enter. In children that is an important point. Doctor Torek's method is a closed method. It is strictly surgical. The one point is that it is a delicate operation. Particularly in children great care has to be used in handling the organ. One must not be rough. But if these points are observed the results are excellent.

Personally, he had done the operation thirty times and all of them show a very satisfactory result. There is a well-developed pendulous scrotum and the testicle is situated at the lower part of that scrotum.

In patients with bilateral undescended testes he always does the operation in two stages for several reasons. It has to be done carefully and takes time, frequently as long as one and a half hours. There must be no undue tension on either scrotum or testicle and this is best accomplished by doing one side at a time. The organs have a better chance to accommodate. At the first session one testicle is brought down, the next operation is done about six months later, when the first side is separated and the other side brought down. The third operation consists of simply separating the second side. There is no definite period which should be allowed between operations. He had found six months to be sufficient time to allow the organs to accommodate themselves to their new position. There has never been retraction of a testicle. One may wait longer if one so desires.

DR JOHN H. GIBBON (Philadelphia) emphasized two points which he considered of prime importance irrespective of the type of operation done. First was the necessity of freeing the component parts of the cord from surrounding tissues and from one another, this is the only way the testicle can be brought down without tension. The mere cross-section of the sac and the high removal of the proximal portion is but the first step in the mobilization.

The second point was the preservation of the blood-vessels even the veins, because in applying ligatures the tiny but essential arteries may be included. On this point

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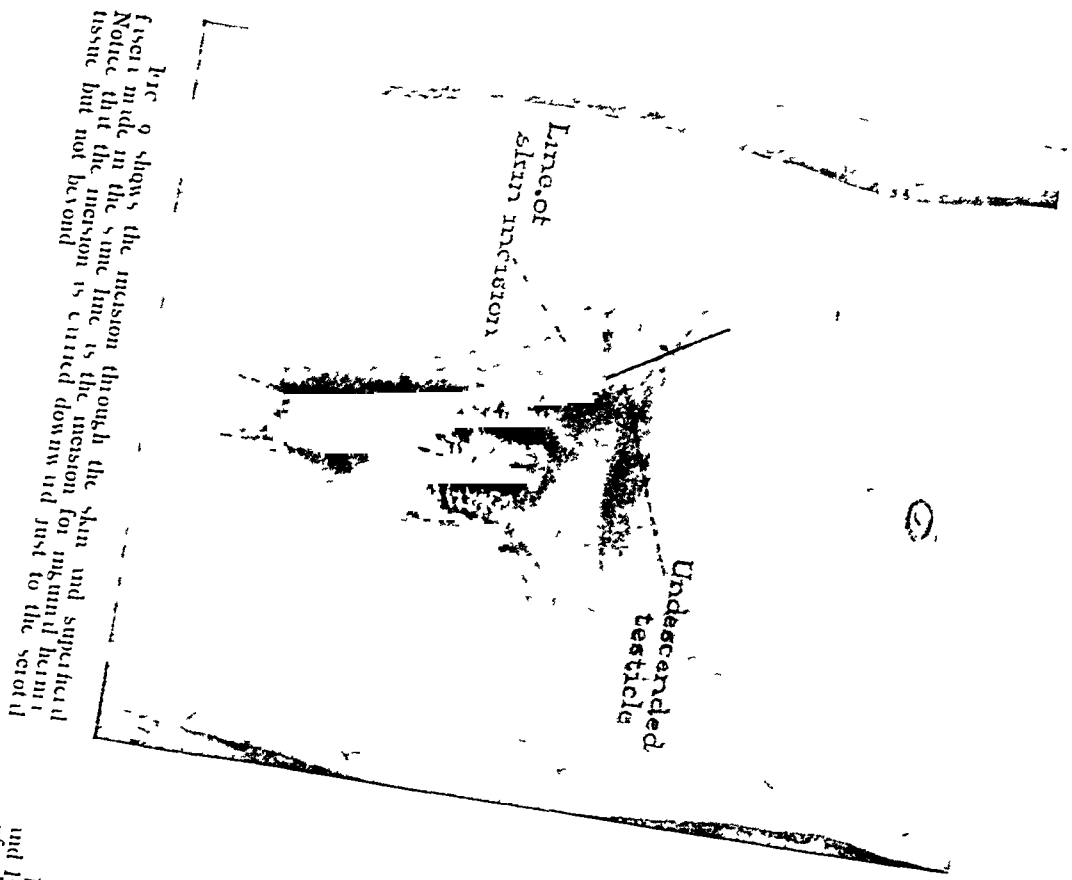


Fig. 9 shows the incision through the skin and superficial fascia made in the same line is the incision for inguinal hernia but not beyond

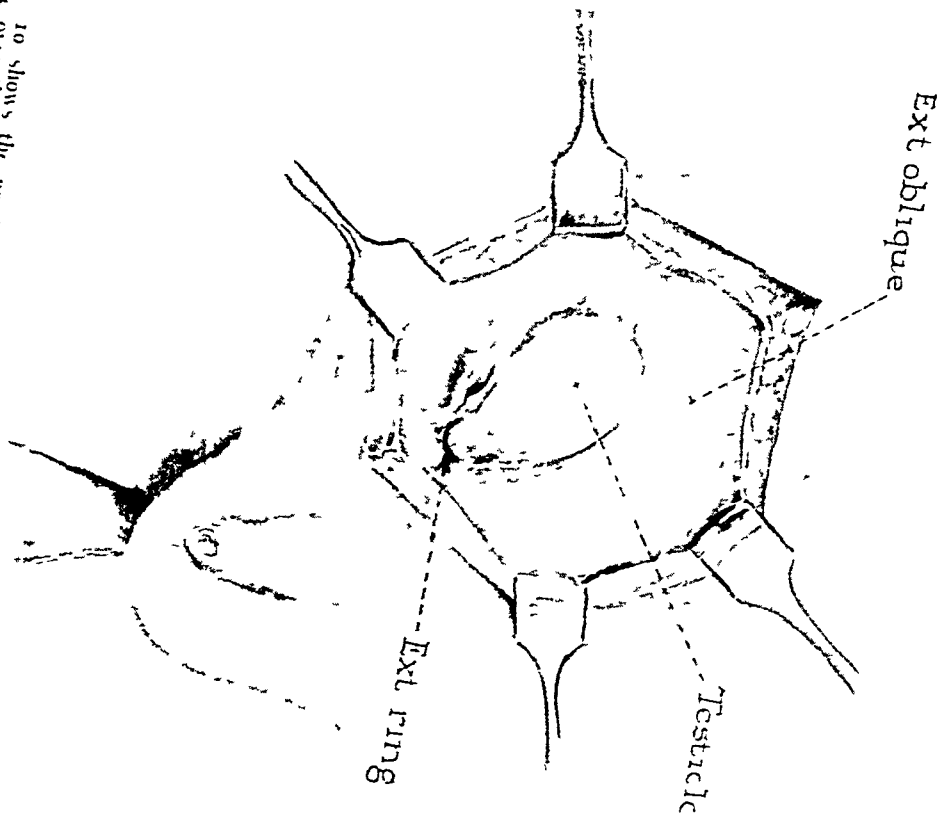


Fig. 10 shows the position of the testicle outside of the inguinal canal and lying over the inguinal canal This is the position found in the majority of cases

hang the future position and development of the testicle Doctor Bevan long ago gave up the division of the veins of the cord which he had originally recommended in certain difficult cases

DR ARTHUR DEAN BLVAN (Chicago) remarked that the purpose of operations for undescended testicle is to do in the period which is required to perform the operation, say an hour, what nature does slowly and gradually in the normal descent of the testis in a period of weeks and months. A great many men who have undertaken these operations have not had a complete conception of the anatomy or of the technic that is required to do the operation successfully. It is absolutely essential that the operator should know that in freeing the testis it is necessary to remove completely from the

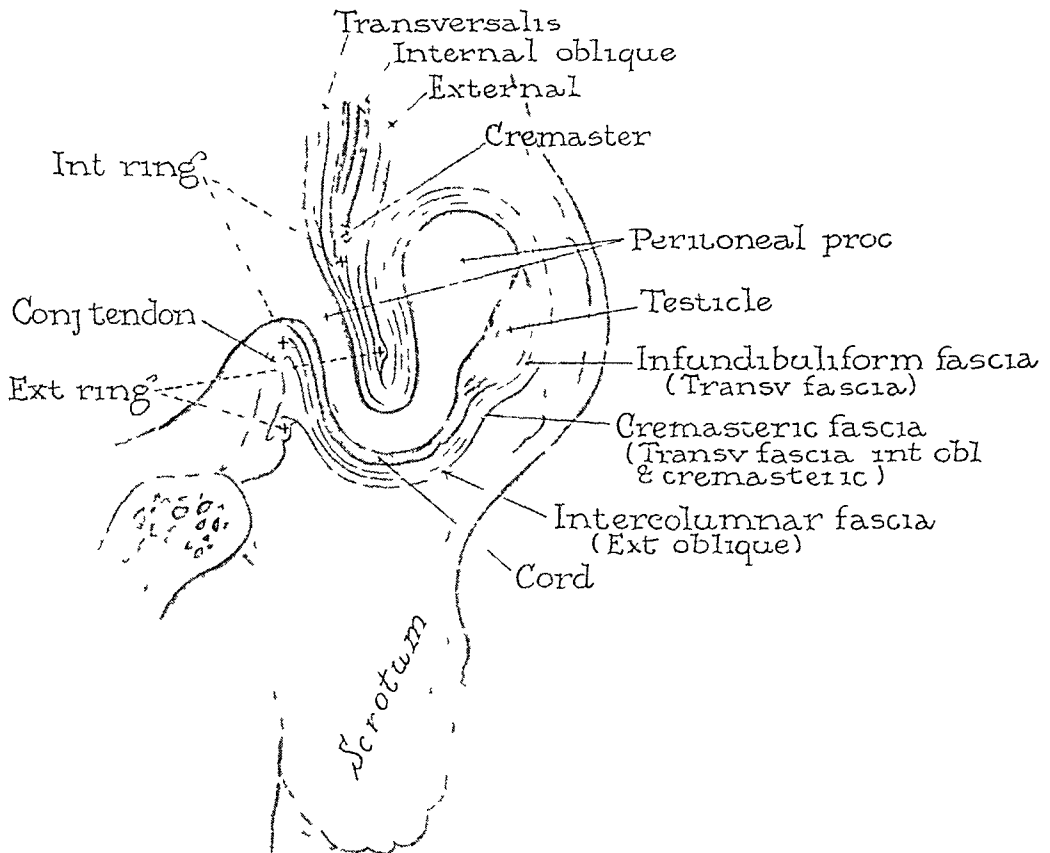


FIG 11 shows a cross section of this anatomical area and shows the position of the testicle, and in addition to the skin and superficial fascia shows clearly the three layers of fascia the intercolumnar the cremasteric muscle and the infundibuliform fascia surrounding the cord and the testicle. It also shows the vaginal process of peritoneum

cord the following structures which surround the testicle and the cord the intercolumnar fascia, the cremasteric muscle fascia and the infundibuliform fascia, as well as to strip the cord completely of the vaginal process of peritoneum. The steps of the operation can be best shown by the illustrations which were drawn by an artist from an operation (Figs 9, 10, 11, 12, 13, 14, 15, 16 and 17)

He had done a large series of these operations. He could not see any fair indication for complicating the operation of undescended testis with any scheme of suturing the testicle to the thigh or of holding the testicle down with traction sutures of any kind during the process of repair. Before undertaking work of this kind the surgeon should know that there is a certain proportion of cases, possibly 10 per cent, in which the organs are so illy developed (often the testicle is a mere rudimentary bud) in which

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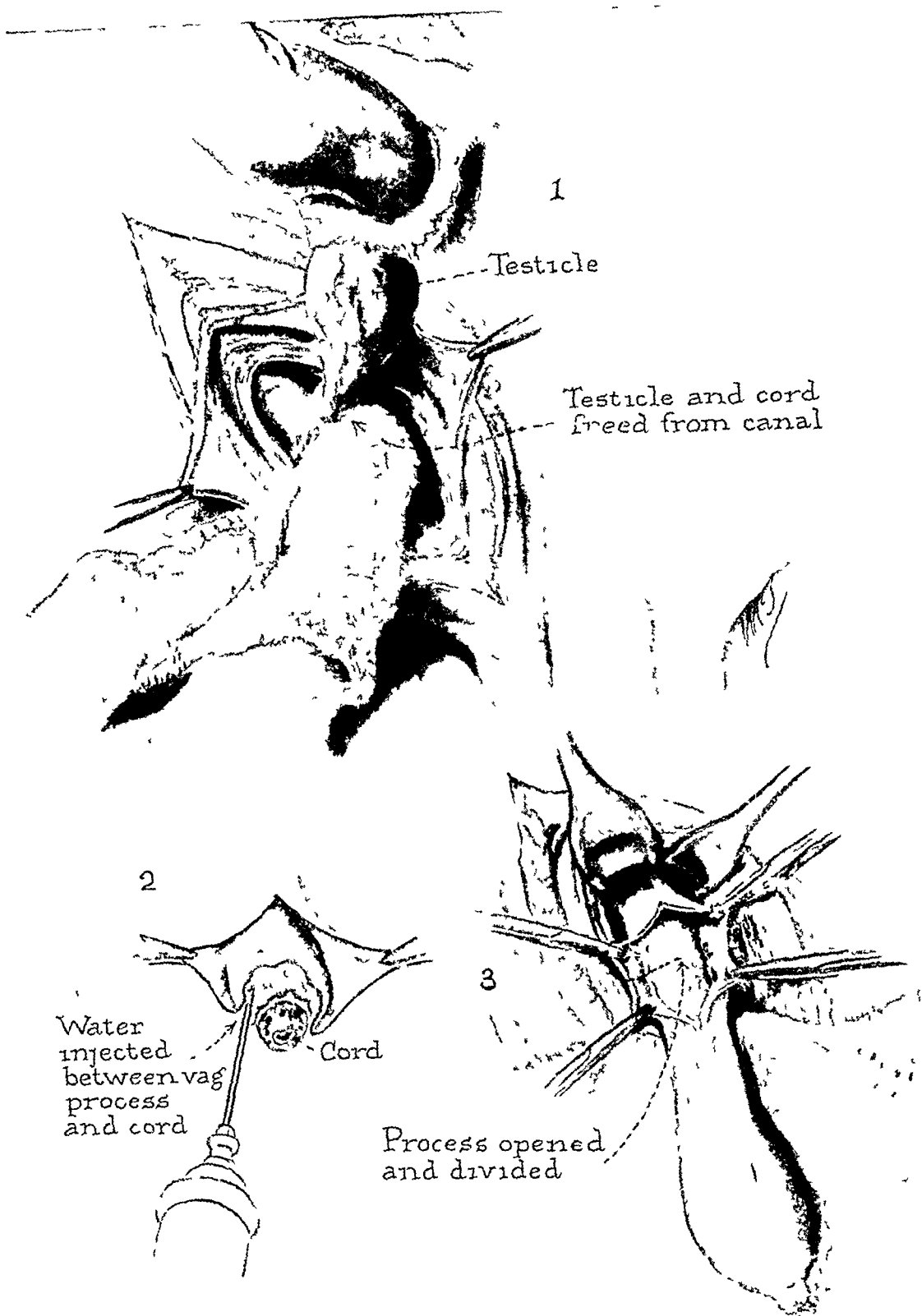


FIG 12 shows the testicle and cord lifted out of the canal after the external oblique has been divided up to the internal ring and below this it shows the injection of normal salt solution beneath the vaginal process of peritoneum in order to lift it off from the cord and make the transverse division of the vaginal process easier

the structures of the cord are so short or in which the testicle is still well up in the abdominal cavity, that it is impossible to bring the testicle down and place it in its normal position by any method of operation. Some of these rudimentary testicles are

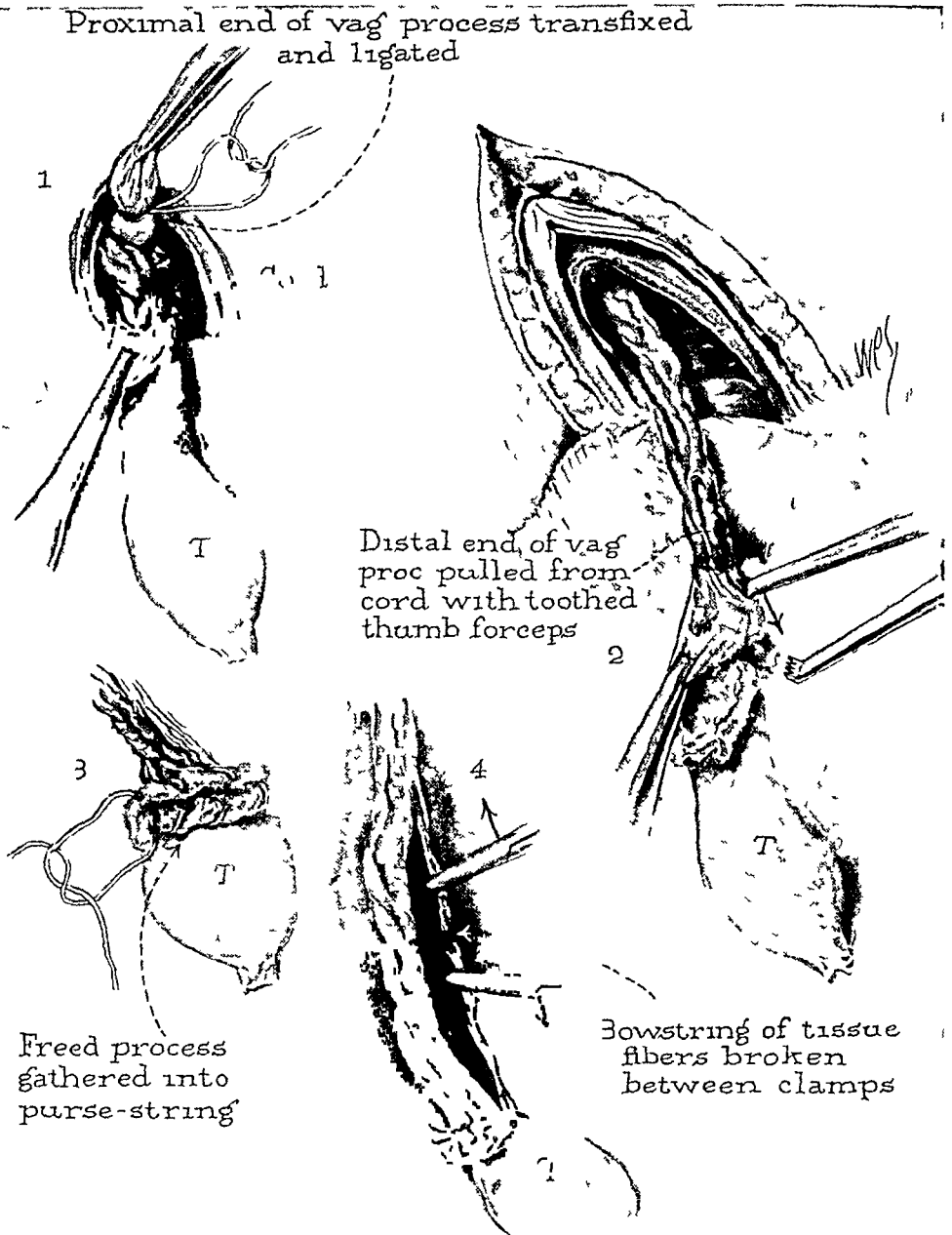


FIG. 13 shows the complete stripping off from the cord of the intercolumnar fascia, the cremasteric muscle fascia and the infundibuliform fascia from the internal ring down to the testis and the closure of the upper end of the vaginal process transfixion and ligation as we do in closing an inguinal hernial sac, also the forming of a tunica vaginalis by closing with suture the lower end of the vaginal process of peritoneum just above the testicle. It further shows the tearing across of some strands of connective tissue from the cord in order to secure complete lengthening.

best removed. Occasionally where the cord is very short and the testicle otherwise fairly normal it may become necessary to divide the spermatic vessels in order to lengthen the cord sufficiently to place the testicle in its normal position in the scrotum.

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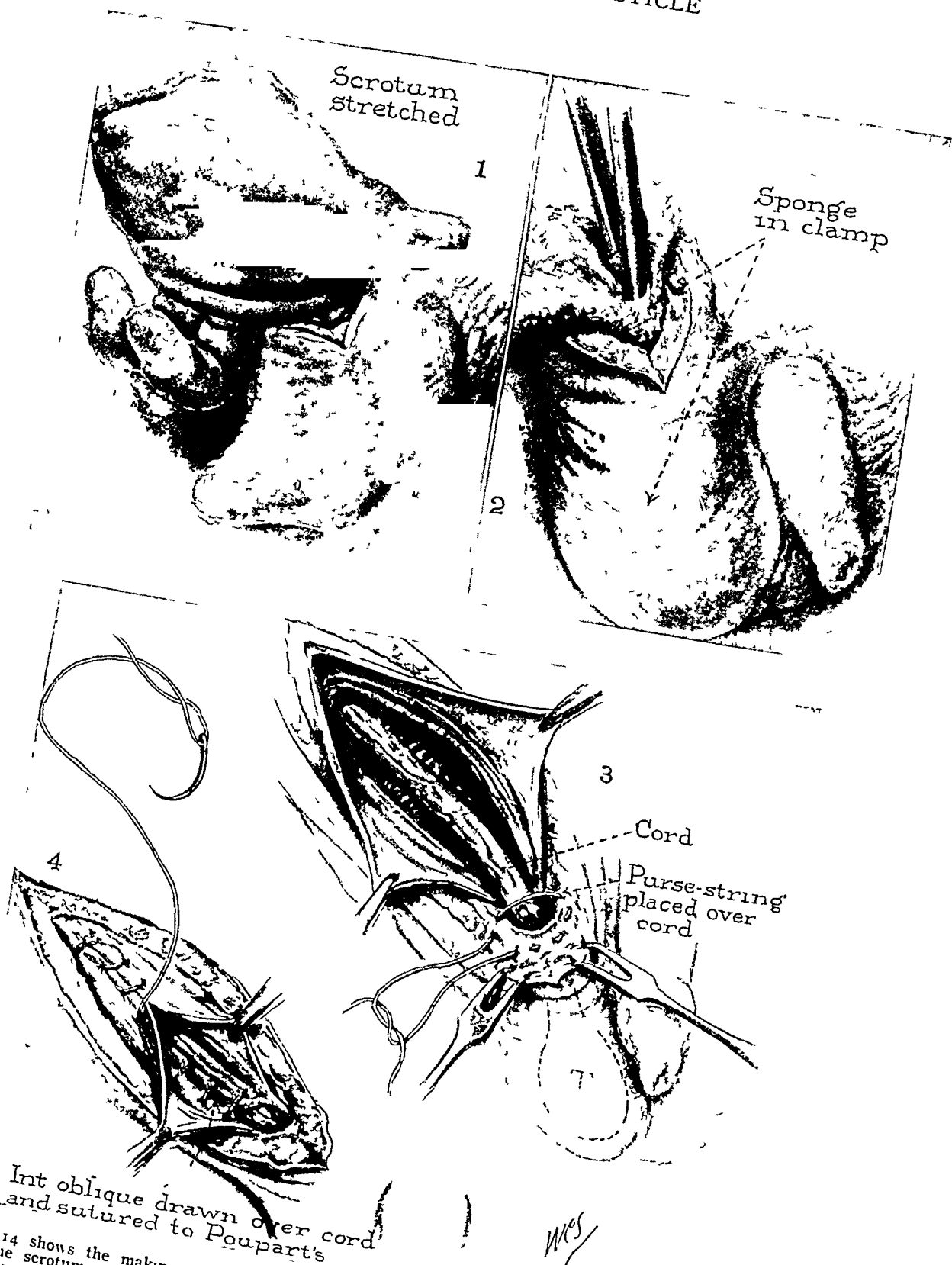


FIG 14 shows the making of a pocket in the scrotum, first with the fingers and then by packing the scrotum very fully with a gauze sponge. The lower part of this plate shows the introduction of a purse string suture at the neck of the scrotum, this suture, of course, being placed in front of the cord and in such a way so as not to compromise the cord in any way. It also shows the closure of the structure over the canal the bringing of the cord in any way to the shelf of Poupart's and the closure of the external oblique to the edge of Poupart's



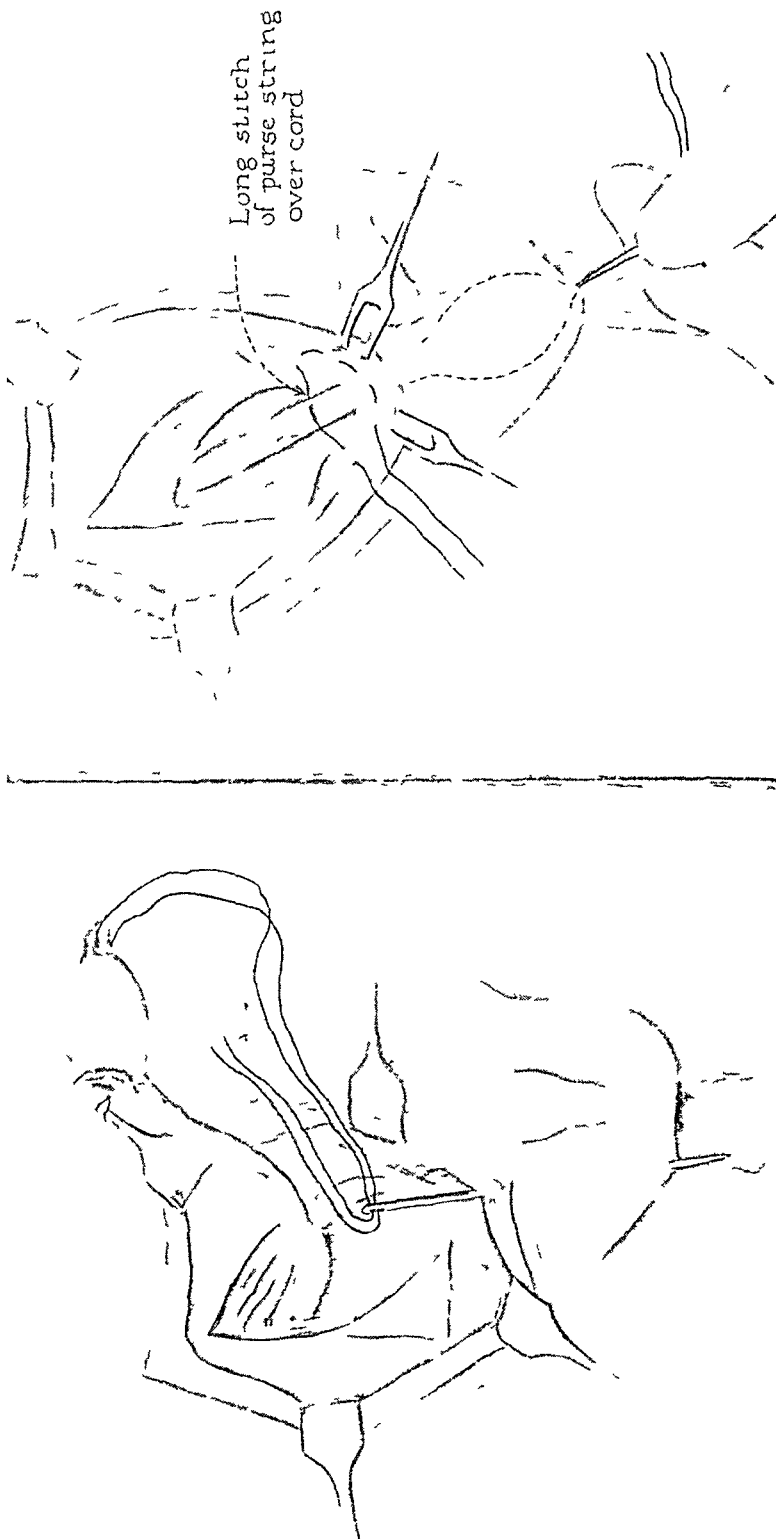


FIG 15

FIG 16

FIG 15 shows a step in the operation which simplifies the placing of the testicle into the scrotum and retaining it there while the operation is being completed that is the placing of the purse string suture at the neck of the scrotum. You will see in this plate that we have put a fine catgut suture through the fibrous covering at the lower end of the testicle. We then threaded this suture double through the eye of a straight needle and carried the straight needle down to the lower part of the scrotum after the pocket has been made.

FIG 16 shows an assistant holding the testicle well down in the scrotum during the introduction of the purse string suture at the neck of the scrotum and the closure of the canal, when the operation is completed one strand of this catgut is divided and the entire catgut pulled out. This is easily done as we do not tie the catgut into the lower end of the scrotum.

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He very seldom divided the vessels and yet undoubtedly in a limited number of cases it is better to do this than it is to drop the testicle back into the abdominal cavity or to remove it because in a fair proportion of the cases operated on in early life, even though the vessels are divided, the blood supply is sufficient to carry on the nutrition of the organ.

If these testicles are operated on at the age of five or six years, which is probably the most favorable age, they can be very easily done then, most of them can be brought well down. The time to operate on these cases is very early, long before puberty. It does not do any good at all to operate after puberty except for the psychic effect and for the cure of an associated hernia.



FIG 17 shows the usual result obtained in a case of this kind. This is in a boy of about ten years of age.

DR FRANZ TOREK (New York City) said that it was quite natural that every surgeon would select the technic that appealed to him and that he was most accustomed to employing. Ordinarily, before an association such as this one, minor points in technic seem insignificant, but as some of them have been brought up he should like to say something about them.

One point was the attachment of the scrotum to the thigh by a subcuticular continuous suture. He has always used the interrupted suture through skin and subcutaneous tissue, and he tries to get a broad apposition of raw tissue, which is done by taking very little skin and a good deal of raw tissue, in adapting the parts. He has felt that in this operation, just the same as in other surgery, especially in plastic surgery, the important thing is to get a very accurate apposition which leads to the promptest and most certain healing. Consequently, he has adhered to the suture through the skin.

and subcutaneous tissue, and has had no reason for deviating from this method of suture because in his cases the scrotum has always remained attached, and, as he sees, with the other method there have been two cases where it loosened

Another point, which is not simply a technical one but one of more fundamental importance, is the attachment of the testicle to the fascia of the thigh, not by interposition of any other structure but a direct attachment. The reason why he considers this to be of fundamental importance is because they have to deal, at least in their bad cases, with a rudimentary testicle or at least a very poorly developed one. These badly developed testicles usually have very small and short vessels so that probably they are not well nourished from their own vessels and the attachment of the thigh gives the testicle a new supply of blood. It is possibly the addition of this supply from a new source which has something to do with the fact that in all their cases the testicles have increased in size.

He called attention to a publication that appeared last year by Wangenstein, of Minneapolis, who practices the operation in the same way as Doctor Torek does, with one exception—namely, in the attachment of the testicle to the thigh he leaves the tunica vaginalis communis intact, incising the scrotum only down to this tunic but not through it. Then he passes his sutures through the testicle and through the tunica vaginalis communis before anchoring them to the thigh.

Doctor Torek believes this to be a mistake, as it fails to give the testicle nutrition from a new source.

The matter of bringing both sides down at the same time has been mentioned. He certainly admits that there may be some cases in which it is possible. Where, however, they have to deal with an absolutely rudimentary scrotum he does not think it would occur to anybody to try it because they simply have not enough skin to go across from one side to the other.

There is one thing that has impressed him very forcibly and that is the question of the action of the pituitary. He hopes that will be investigated further. If it proves successful, if the action of the pituitary should establish sufficient development of scrotum and testicle, the operation he has described would no longer be needed. The assumption that an endocrine element has something to do with the descent and development of the testis seems to be supported by Doctor Lyle's observation that after he had brought down one testicle and it had developed properly, the other testicle descended without operation. All of these things have to be studied.

# OMBRÉDANNE'S POUCH OPERATION FOR HYPOSPADIAS

BY HENRY H M LYLE, M D

OF NEW YORK, N Y

THE object of this paper is to call attention to the satisfactory and constant results obtained in Ombredanne's pouch operation. We feel that the merits of this operation should be better known in this country. The surgical text-books do not mention it, the urologists apparently ignore it.

The uncertain and discouraging results obtained after a conscientious trial of the standard operations for hypospadias decided us to abandon operative therapy when we had the good fortune, while in Paris, to observe Ombredanne's pouch operation.

The Ombredanne operation introduces an entirely new principle in the plastic repair of the urethra. The fundamental advantages are that the pouch urethra delivers the urine to the meatus without the possibility of leakage, and that there are no lateral edges to separate. It does away with the necessity of diverting the urine by an indwelling catheter, an external urethrotomy or a suprapubic cystotomy.

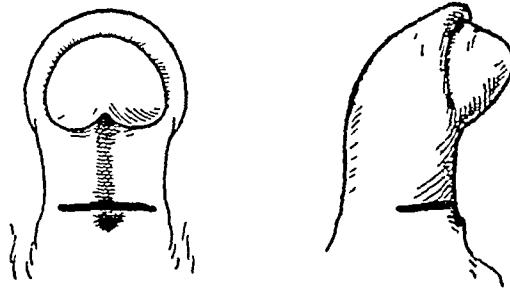


FIG 1—Transverse incision for lengthening the organ

*Preliminary Preparation for Operation—Straightening the Penis*—(Fig 1) The majority of hypospadiacs have an associated incurving deformity of the penis. This deformity must be corrected and sufficient time allowed to elapse before the Ombredanne operation can be undertaken. The deformity is not caused by the shortening of the skin but by the presence of fibrous bands and aplastic tissue, these pathological tissues prevent the corpora cavernosa from assuming their proper length. These bands and tissues are excised and the corpora cavernosa freely exposed. As a result of this the hypospadiac meatus recedes posteriorly and the transverse incision becomes an oblong gap. The opposing edges are then sutured and the penis fixed in hyperextension (Fig 2).

*After-care*—The sutures are removed on the twelfth day but hyperextension is maintained until the tissues become pliable. This time varies from two to four months.

Ombredanne's pouch operation is performed in two stages. The first stage

is an autoplasmic procedure which gathers under the glans a mass of tissue, designated by Ombredanne as the "tubercle." Its length equals the glans but it is separated from the part by two lateral furrows. In the second stage the "tubercle" is united to the glans.

*First Stage*—A detailed description of the operative technic employed in penile hypospadias will be given, and comment on the modifications required in the glandular and perineal types made.

(1) *Technic of an Operation for Penile Hypospadias*—The placing of the purse-string stitch (Fig 3a). A linen suture outlines the periphery of the sac. The length of the distal portion of the flap corresponds to the distance from the hypospadiac meatus to the extremity of the glans, the proximal half of the flap being equal to that of the distal. At the level of the glandular furrow (Fig 3b) the needle is passed under the mucosa and the mucosa lifted in order to avoid the larger veins. The stitch is continued under the mucosa of the glans to its tip and then carried down on

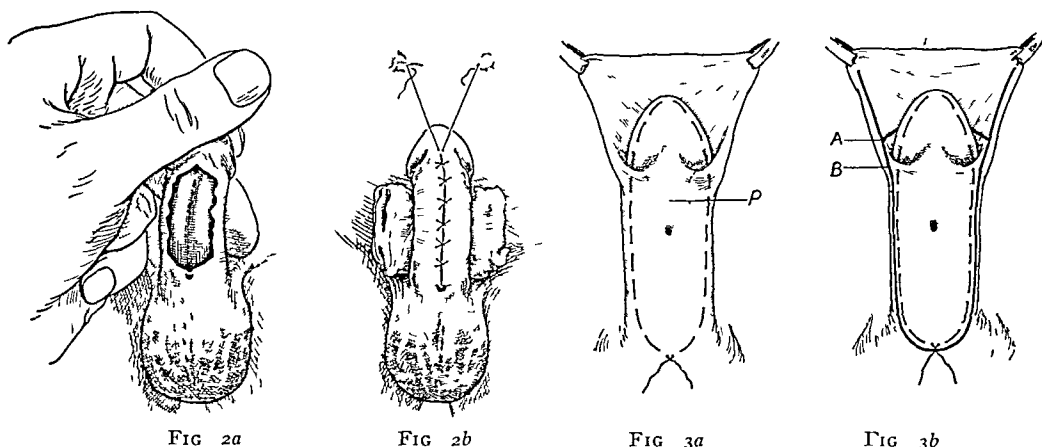


FIG 2—(a) Freeing of corpora cavernosa the transverse incision is now an oblong gap. The hypospadiac meatus has receded posteriorly. (b) Fixation of the penis in hyperextension during healing of tissues.  
FIG 3—(a) Placing of the puckering stitch. The flap P is left adherent. (b) Outlining the lateral and preputial flaps.

the opposite side to a point where it was originally inserted. The breadth of the flap is equal to one-third the circumference of the penis.

(2) *Dissection and Liberation of the Flap*—(Fig 4a). The proximal half of the flap should be carefully dissected up to the level of the hypospadiac meatus. When the dissection approaches the meatus a catheter is inserted and great care taken to avoid damaging the skin and mucous membrane as they are often reduced to a paper-like thinness. A misstep here may ruin the final result. The portion of the proximal flap extending from the hypospadiac meatus to the glans, and equal to the breadth of one-fourth of the circumference of the penis, is left adherent (Fig 3a). It is this base that furnishes the blood supply for the future urethral sac. The outlining incision is made 15 millimetres external to the puckering suture. The incision bifurcates at A, the vertical limb passes upward to the angle of the stretched prepuce, and the horizontal limb encircles the mucosal surface of the prepuce parallel and two millimetres from the furrow of the glans to meet the vertical incision on the opposite side. The external edges of the horizontal incisions, and the mucosal flap on the prepuce are carefully freed. The sac is now puckered by tightening the purse-string suture, care being taken to allow enough room for the passage of the urine.

(3) *Making the Y-shaped Incision*—(Fig 4b). A Y-shaped buttonhole is cut in the preputial flap. The vertical arm of the Y begins at the level of the collar of

# OPERATION FOR HYPOSPADIAS

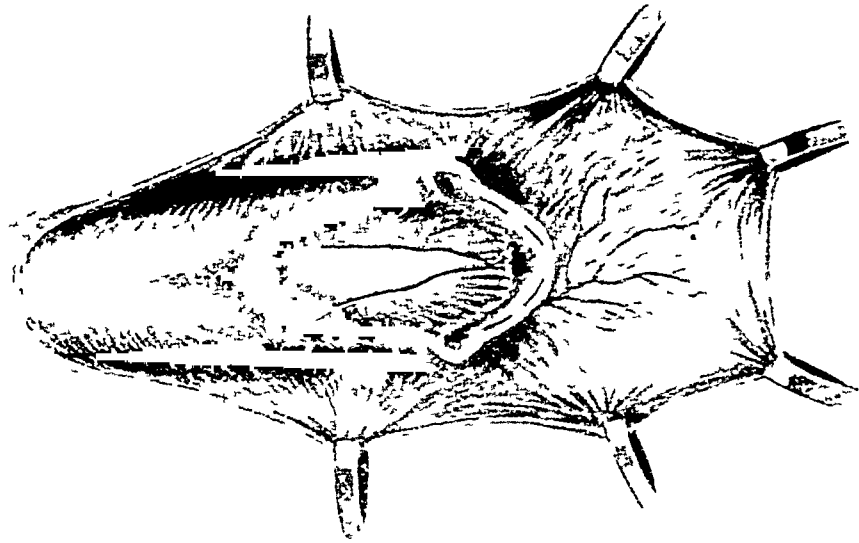


Fig. 4a—All flaps are freed and the sac closed by a purse string suture

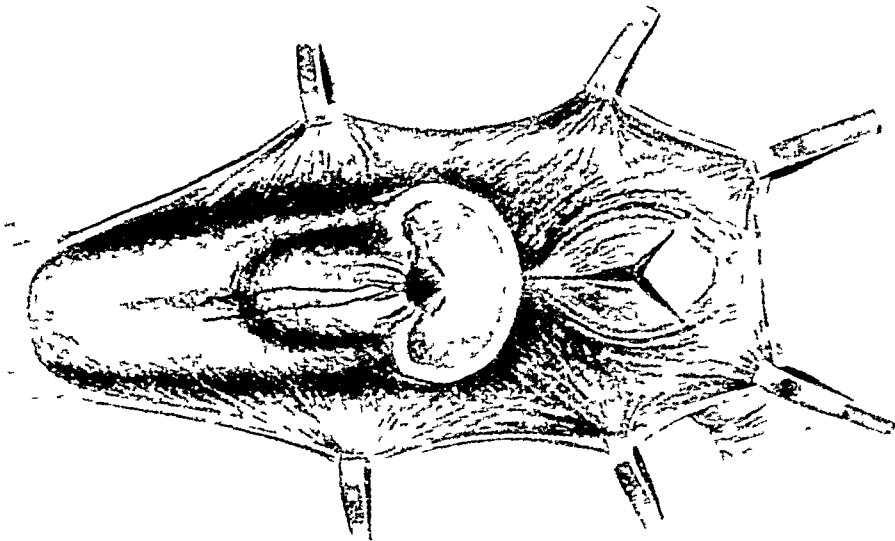


Fig. 4b—Making the Y incision in the preputial flap so that its nutrition is not compromised

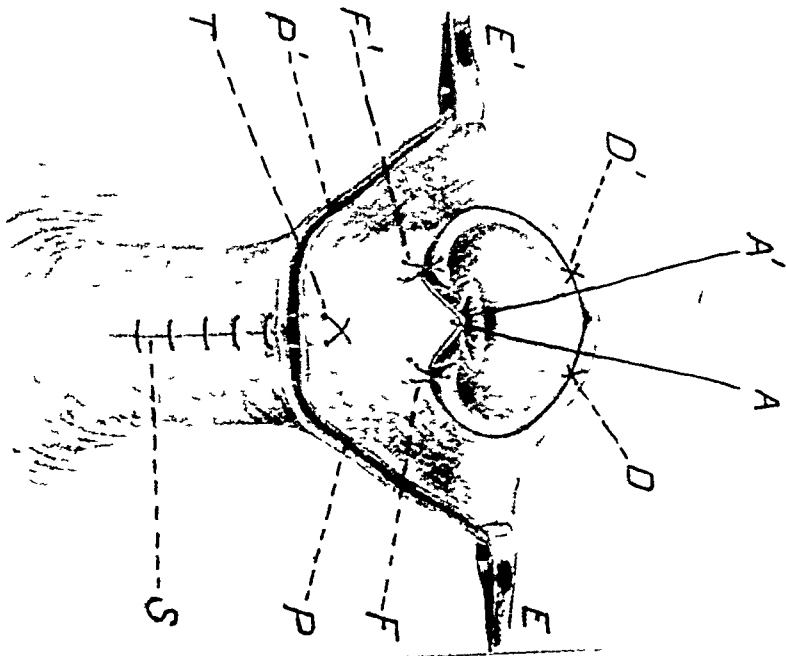


Fig. 5—The flaps are passed through the Y shaped incision and the flap sutured

the glans and is placed in an avascular area between two longitudinal veins. The tip of the left index finger is placed on the cutaneous side of the preputial flap and the vertical incision deepened to the skin. The overlying soft parts having been pushed aside by blunt dissection, the Y-shaped incision is made in the skin. The displacement of the subcutaneous tissue and vessels is an important detail in the conservation of the nutrition of the preputial flap.

(4) *The Passing of the Glans through the Y-shaped Incision and the Fixation of the Flap*—(Fig 5) The preputial flap is put over the glans just as the clergyman puts a stole or chasuble over the head. The glans emerges on the cutaneous surface of the preputial flap while the raw surface of the flap is spread over the inferior surface of the penis. The long ends of the purse-string suture  $A A'$  are passed through the triangular opening and tied.

(2) The triangle, made by the divergent arms of the Y, are sutured on each side of the opening of the sac  $F F'$ .

(3) The shoulders  $E E'$  are grasped with an Allis clamp and pulled out to prevent the formation of fistulæ.

(4) Two sutures are inserted at  $D D'$ .

(5) The edges of the preputial flap  $P P'$  are united.

(6) The preputial flap will not cover all the bed from which the sac was taken, but the remaining raw surface is readily covered by uniting the lateral edges of the original incision along the line  $S$ . The junction of preputial flap to the line  $S$  is secured by a mattress suture  $T$  (Fig 5).

*The Immobilization and Dressing*—(Fig 6) The penis should be gently stretched for four or five days so that the preputial flap becomes fixed without the formation of folds. This position, if maintained correctly, diminishes the accompanying

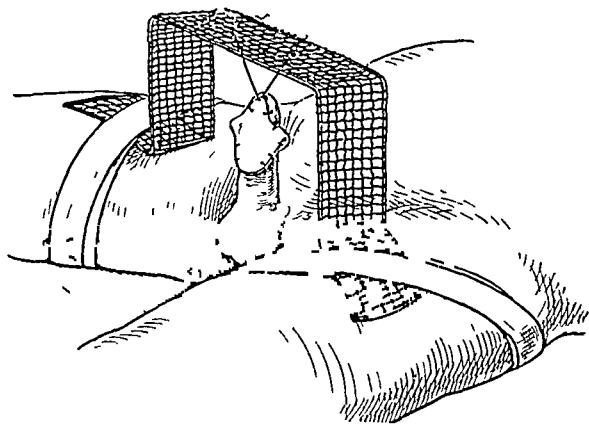


FIG. 6—The suspension of the penis to allow the flaps to unite without folds

œdema. No dressings are required—simply wash the parts after urination and dust with a bland antiseptic powder.

*Complications*—If the sac has been made too long, a small point of this flap may slough. This is of little importance because the preputial flap practically never sloughs but becomes adherent to the rest of the sac and assures a channel for the urine until the second stage of the operation is undertaken.

*Post-operative Œdema*—Post-operative œdema can be reduced to the minimum by gentleness, the avoidance of interference with the nutrition of the flaps as outlined above and by careful post-operative care. The dependent position is to be avoided and all traction to be of the gentlest nature. If the œdema becomes excessive, puncture the œdematous mucosa with a needle and apply a mild solution of adrenalin.

*Perineal and Vulvoperineal Hypospadias*—(Fig 7) The first stage of the repair of this deformity consists in turning the perineal orifice into a penile orifice. In order to do this the cutaneous posterior flap may have to be carried back almost to the anus. At the root of the penis it is necessary to make a second small lateral incision to permit the forming of two scrotal flaps to cover the mass of the sac at its new orifice. The perineal meatus is now converted into a penile meatus and when this newly formed penile orifice is well established we proceed as described above. Ombredanne states that in some of the very difficult cases he has made three successive sacs.

## OPERATION FOR HYPOSPADIAS

*Glandular Hypospadias*—In those cases requiring operation the same technic is used as in the penile hypospadias. As the prepuce is ample the raw surface and small sac are readily covered.

*The Second Stage*—A period of approximately four months is allowed to pass

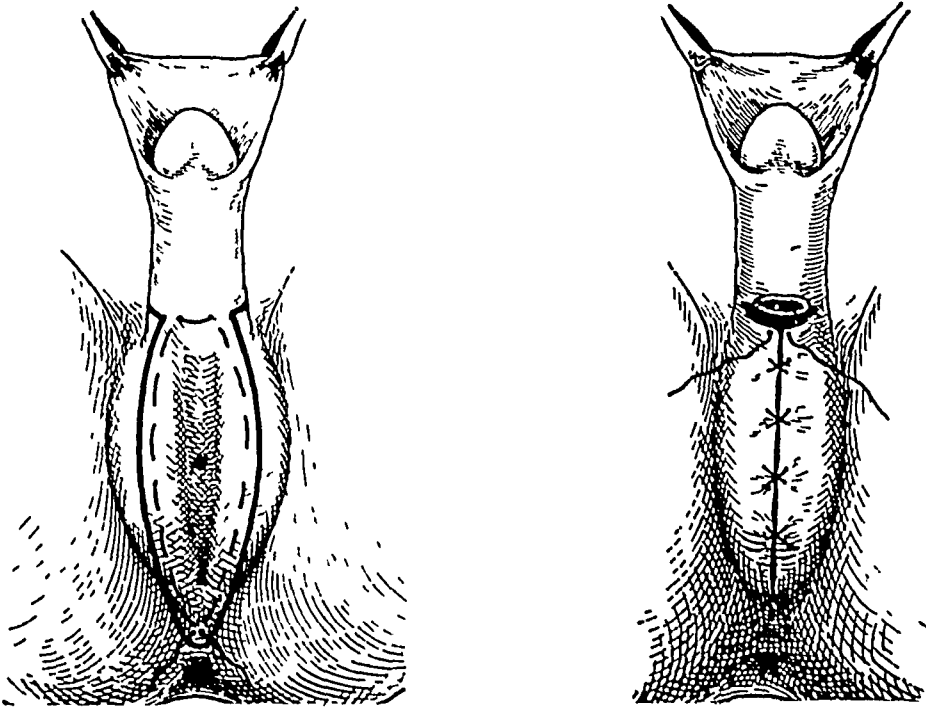


FIG 7—Method of treating a perineal meatus. The sac is advanced in two stages. The perineal meatus becomes a penile meatus.

before the second stage is undertaken. This stage consists of the union of the “tubercle” to the glans.

*Refreshing the Edges*—The mucosa at the summit of the glans is grasped with an

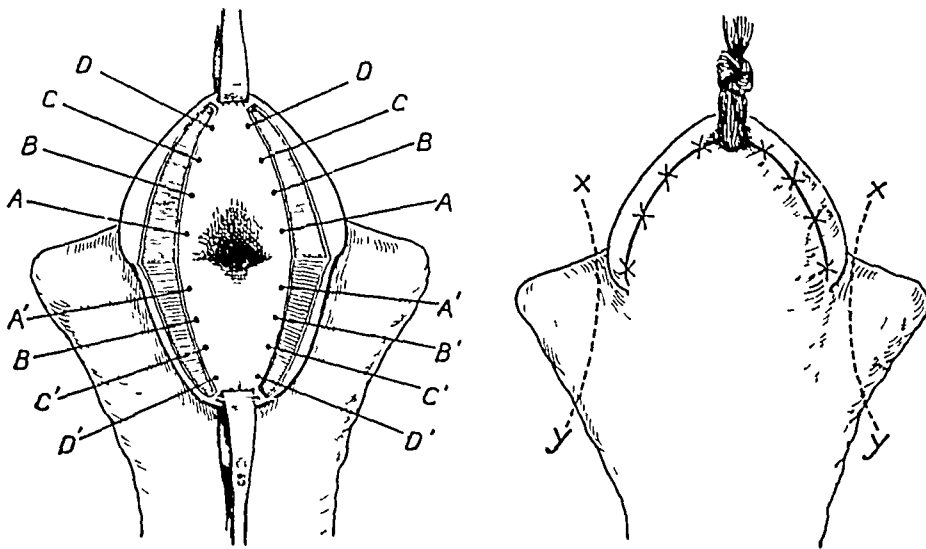


FIG 8a

FIG 8b

FIG 8—(a) Union of the “tubercle” with the glans, the internal layer of sutures. (b) Union of the “tubercle” with the glans. The long ends of the internal sutures have been brought out through the meatus and knotted. The external sutures have been placed and tied. X, Y, direction of the lines for excision of the ears.

Allis clamp and a second one is placed on the summit of the “tubercle.” Retraction is made in opposite directions and the reconstructed canal will open like the bill of a whip-poor-will, exposing all the details of the interior. The cutaneous portion of the lining may already



show a growth of hair. With a fine curved scissors the hair with a complete thickness of skin is excised. Retraction should not be feared. If desired or necessary the whole cutaneous area of the inferior surface can be safely excised as there is sufficient mucosa on the roof of the canal to furnish a complete covering. This will prevent the possibility of hairs projecting from the meatus. The breadth of tissue grasped by the clamps indicates the size of the meatus. A broad strip of tissue three to four millimetres in thickness, extending between the clamps, is excised. Internally a strip of mucosa five to six millimetres broad is reserved, externally as much as is needed can be removed. In preparing the raw surfaces of the glans the mucosa alone is excised, bleeding is thus prevented and an excellent surface for union provided. (Fig 8a)

*The Sutures*—In young children one layer of sutures suffices, while in the adults and older children a double layer is required. The internal layer of sutures consists of fine chromic gut passed through the edge of the mucosa, they are tied and the long ends of the sutures brought out through the meatus and knotted. The external layer of non-absorbable sutures is inserted and tied as in the repair of the cervix, the suture including three-fourths of the denuded surface. (Fig 8b)

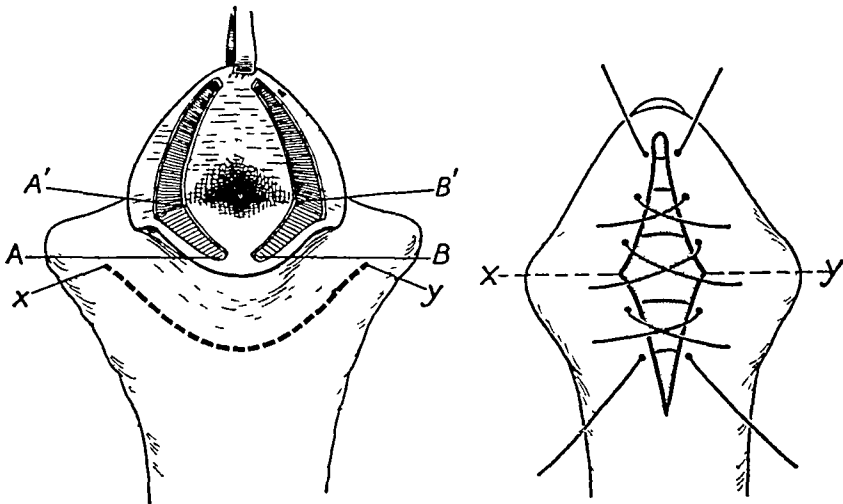


FIG 9a

FIG 9b

FIG 9—(a) Method of union if tubercle is short X Y is a concave transverse incision. (b) Transverse incision is converted into a longitudinal incision to lengthen the tubercle.

*Æsthetic Touching up*—(Fig 8b) Excise the ears (X, Y) and any other cutaneous tags. In doing so avoid cutting into or placing sutures in a possible lateral extension of the pouch.

*Exceptional Cases*—Occasionally there is no rounded "tubercle," the cause being a partial sloughing, or an excessive retraction of the sac. The method of meeting the condition is illustrated in Fig 9ab.

Ombredanne's operation provides a functional organ that differs from the natural penis in two insignificant details. The meatus is triangular in shape and there is a small piece of brownish preputial skin on the inferior surface of the glans.

*Indications and Contradictions*—Mild glandular cases with a straight penis do not require an operation. There is doubt about the advisability of operating on the advanced cases associated with hermaphroditism where it is difficult to determine the sex. It is indicated in all other cases and also in mild glandular types, where the knowledge of the deformity is causing a loss

## OPERATION FOR HYPOSPADIAS

of morale The most favorable time for operation is between the ages of six and eight years

Ombredanne reports 250 cases without a failure We have operated on nine cases, five of these cases are completed and cured, four are awaiting completion The first operation was completed more than three and one-half years ago, one of the completed cases has had a Torek's operation for a single undescended testicle One of the cases in the process of completion has had a single Torek operation for undescended testicle and another has had a double Torek operation Thus in a series of nine cases we have had three patients with undescended testicle The effect of the operation on the morale of a backward country boy is evidenced by a letter we received last Christmas This nine-year-old boy had been operated on one and one-half years ago for a penio-scrotal hypospadias "*Dear Dr Many thanks for what you have done for me, I am the honor boy in fourth class I can lick anybody in the school and can P as far as any of them Merry Christmas from me and Mother*"

*Summary*—(1) The Ombredanne pouch operation for hypospadias yields constant and satisfactory results

(2) The operation is based on a new plastic principle which overcomes the possibility of lateral leakage

(3) It yields a normal functioning organ uninfluenced by erection

(4) The keynote to success is gentleness, thoroughness and personal attention to the details of the post-operative care

In conclusion we wish to acknowledge our indebtedness to Professor Ombredanne We have drawn freely from Ombredanne's *Précis Clinique et Operatoire de Chirurgie Infantile*

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# PRINCIPLES *versus* DETAILS IN THE TREATMENT OF ACUTE EMPYEMA

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IF ANY apology is needed for bringing this hackneyed subject to the attention of this Association again our reason for it is that we feel that the whole question has been much confused by over-emphasis on details of treatment with a corresponding lack of emphasis on the underlying principles. The confusion has become so great in the minds of many that the opinion has arisen that patients with acute empyema are being badly treated unless the particular details recommended by some one or a particular gadget or apparatus recommended by some one else is used. In a general way, the confusing situation has been created by recent enthusiastic advocates of aspiration as a sole method of treatment and by others who have created a feeling that some form of continuous closed drainage is essential or at least desirable. To accomplish continuous closed drainage many instruments and at least one complicated apparatus have been invented.

We hope to be able to show that the concentration of attention upon various details in the treatment of empyema has not accomplished any more good than can be obtained by the application of the general principles which are now well known and that the over-emphasis which has been placed on details by some writers has perhaps been a source of harm.

It is fully recognized that the first object in the treatment of empyema is to save the life of the patient, but there is also a second object, which is to shorten the period of convalescence as much as possible. The experiments which were carried out during the World War by R. D. Bell<sup>1</sup> and one of us<sup>2</sup> showed apparently conclusively that patients with pneumonia or with a beginning empyema were very likely to be killed by the injudicious use of an open drainage. The principal reason for the deaths of such patients was the altered pressure relationships induced by an open pneumothorax. In any individual whose mediastinum is not stabilized, either by induration of the mediastinal pleura, or by the presence of adhesions between the lung and the chest-wall, an alteration of pressure on one side of the chest is reflected to the other side to almost the same degree. The significance of this observation is that both lungs become seriously handicapped and that if the vital capacity is very low, as it is likely to be in any case of pneumonia, the additional embarrassment to respiration produced by the open pneumothorax is sufficient to cause death from asphyxia in many cases. As a matter of fact, the average mortality during the World War, until this principle was recognized, was close to 50 per cent.

The general acceptance of this principle led to the use of various expedients to secure drainage of the pleural cavity without creating an open pneumo-

thorax It is an interesting fact that empirically it has been noted from time to time that in patients with empyema, either in a developmental stage or after it was well established, there was in general a lower mortality rate after some form of closed drainage than after an open drainage It is significant that as early as 1844 Hamilton Roe,<sup>3</sup> before the London Medical Society, reported nine cases of empyema with eight recoveries treated solely by the use of an aspirating syringe From time to time in the literature there appears an enthusiastic account of the efficacy of aspiration as a sole method in the treatment of this condition The most recent version has been aspiration with an replacement It is important to realize, however, that after almost a century of use the procedure has not found for itself a sufficiently secure place to become firmly established It is interesting also that, beginning as early as 1876 with the report of Cresswell Hewett,<sup>4</sup> various methods of continuous closed drainage or continuous aspiration have been recommended from time to time The procedures scarcely differ in any respect except in unimportant details Again, as with the question of repeated aspirations, we must ask ourselves why methods of continuous closed drainage should find favor for a few years at a time, only to be forgotten and then re-discovered and applied by some one else

The answer to this question seems to us to lie in the fact that the mortality rate in cases of empyema is dependent almost entirely upon the virulence of the epidemic of pneumonia, if the surgeon is not responsible himself for the deaths by creating an open drainage too early in the course of the disease The recent recrudescence of enthusiasm for treating empyema exclusively by repeated aspirations or by continuous closed drainage is probably to be explained by the fact that in recent years the mortality rate from pneumonia and, therefore, from empyema, has been comparatively low We venture to suggest that the periodic advocacy of such methods with an intervening lapse of years in which they are not advocated is due to the fact that the methods seem satisfactory during the years when the mortality figures are low but that when the mortality figures become high again the methods are advocated with less enthusiasm or completely forgotten

A careful study of this question beginning during the war, while one of us was a member of the Empyema Commission, and carried on since then, has convinced us of several facts The first and most important is that patients rarely, if ever, die from empyema itself They die because of the complicating pneumonia, the presence of other severe complications such as brain abscesses, meningitis, peritonitis, *etc.*, or because they have had an open drainage created at a time when such an open drainage produces a fatal asphyxia Another fact which has seemed to us to be firmly established is that if care is taken to avoid the creation of an open pneumothorax during the formative period of an empyema, it makes practically no difference so far as mortality is concerned whether the case is treated continuously by some form of closed drainage or by the institution of an open drainage after a true empyema, that is, a true abscess, is present If one recognizes

the importance of the principle of avoiding an open drainage during the dangerous period while a pneumonia is still present and before there is an actual abscess of the pleural cavity, his mortality figures, regardless of what details he uses from then on, will be about the same as are those of the advocates of this, that or the other procedure

If the fact is accepted that the mortality rate can be scarcely influenced by the details of treatment, provided always that the patient is not killed by the injudicious creation of an open drainage at the wrong time, then our attention should be directed to the second most important consideration in the treatment of empyema. This concerns the prevention of chronicity. The limited time at our disposal will prevent our giving a satisfactory and convincing discussion of this question. It will, therefore, be necessary to become somewhat dogmatic by saying that after trials of various procedures we have become convinced that the most satisfactory method of treating a case of acute empyema after it has really become an abscess is to drain it by an open drainage, and in our experience the most effective way to accomplish adequate drainage at this time is by the resection of a portion of a rib at the most dependent portion of the cavity. This procedure carried out over a period of years at the St. Louis Children's Hospital (see Table I) has enabled us to discharge the average patient with his cavity completely obliterated in a period of five weeks and two days from the time that the fluid was first recognized in the pleural cavity. Many cases were discharged in much less time but some required a longer time. This average compares favorably with, and we think on the whole is superior to, the average period of healing reported by those who adhere to methods of continuous closed drainage or repeated aspirations as a sole method of treatment. The question of irrigation of the cavity in our opinion is of only slight importance compared with the principle of avoiding an open pneumothorax during the formative period of the empyema.

TABLE I  
*Cases of Empyema in which Surgical Drainage was carried out*  
 1925-1930 inclusive  
 St. Louis Children's Hospital  
 (Statistics Compiled by Dr. H. C. Ballou)  
 Number of Cases 116                      Number of Deaths 13  
 Mortality 11.2 per cent

Year	Number of Cases	Healed	Dead	Percentage
1925	15	15	0	0
1926	17	13	4	23.5
1927	11	10	1	9.0
1928	21	19	2	9.5
1929	23	19	4	17.3
1930	29	27	2	6.9

Of these, thirty-six cases were children two years of age and under, with eight deaths, a mortality of 22 per cent. Eighty cases were children over two years of age, with five deaths, a mortality of 6.2 per cent.

## PRINCIPLES *vs* DETAILS IN TREATMENT OF ACUTE EMPYEMA

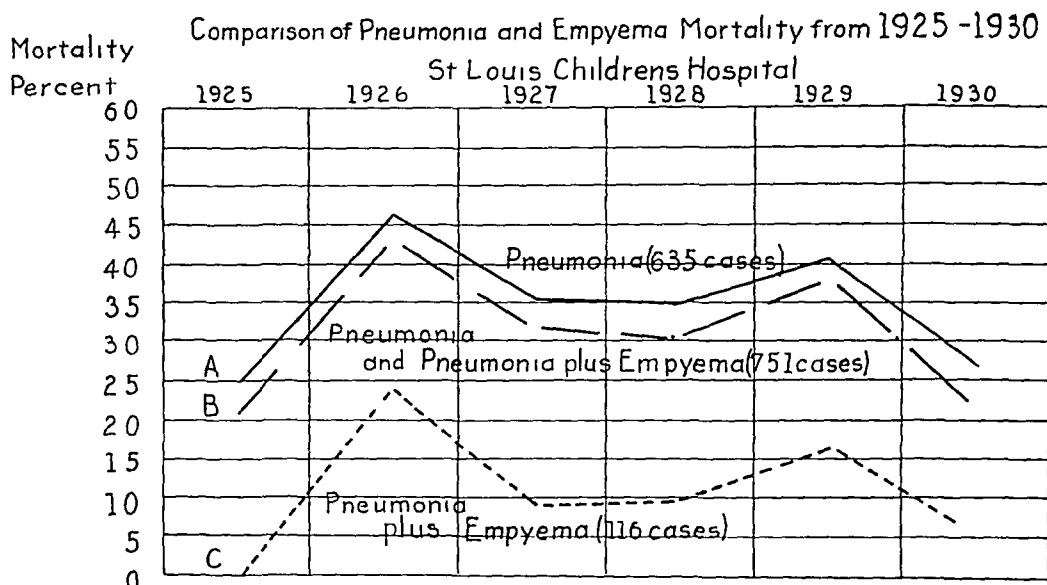
As a means of preparing patients for an open operation we usually employ aspirations from time to time as the occasion demands but sometimes we use a method of closed continuous drainage. We do not feel that these details are important.

Our chief bone of contention with those who emphasize details rather than principles and, therefore, particularly those who in recent years have advocated either continuous closed drainage, or repeated aspirations as the sole method of treating cases of acute empyema, is that the latter frequently convert an acute empyema into the more serious condition of a chronic one by allowing the most favorable time for open drainage to slip by. If they do not do this but instead create an adequate open drainage at the proper time then they are advocating only those procedures which we have recommended since 1918. As a matter of fact, Bienneman, who has been one of the leading recent exponents of aspiration as a sole method of treatment, has informed one of us that he is recommending an open drainage in more cases than he did formerly.

It is perhaps advisable at this point to call attention to the fact that nearly every case of acute pneumonia will reveal some fluid in the pleural cavity if an aspiration is performed. This fluid is serofibrinous or serohæmorrhagic. Even although leucocytes and bacteria may be found in it on microscopical examination, it does not indicate an empyema in the sense of a true abscess. In most cases this fluid will be absorbed as the pneumonia clears. Statistics, therefore, based on the recovery of such patients after aspiration or continuous closed drainage are often misleading.

While we were collecting data on the points involved in this paper Heuer's<sup>5</sup> excellent article appeared which also called attention in a striking way to the fact that the mortality rate of acute empyema is governed almost entirely by the severity of the violence of the epidemic provided that the surgeon does not himself kill the patients by the injudicious creation of an open pneumothorax during the development of the empyema.

The accompanying curves (Figs 1 and 2) show in a striking manner how closely the mortality rate of acute empyema has paralleled that of pneumonia in the St. Louis Children's Hospital over a period of years. This parallelism has occurred despite the fact that during the years represented the cases of empyema have been treated by a uniform procedure which has consisted of aspirations as often as indicated, to be followed by open drainage when frank pus, or a true abscess, is present. If only the year 1925 had been selected we might have concluded that we had an infallible method because no deaths occurred in that year. If, on the contrary, we had studied only the cases of the following year (1926) we should have felt that there was something radically wrong with our method because our mortality then was 23.5 per cent. The variation in the mortalities from year to year shows the futility of basing claims of superiority for a particular method of treatment on only a few cases or even a large series of cases treated over a period of only one or two years. This fallacy is probably the explanation of the

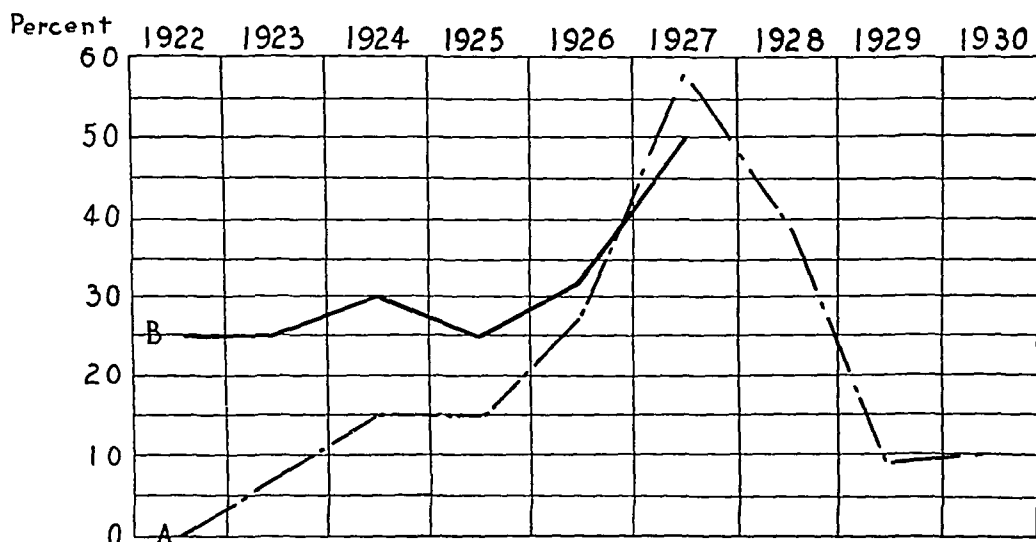


A is the mortality curve in 635 cases of pneumonia without empyema

B is the mortality curve of these 635 cases of pneumonia without empyema combined with the mortality of the 116 cases of pneumonia with empyema (combination of curves A and C)

C is the mortality curve of the 116 cases of pneumonia complicated by empyema

FIG 1—The mortality curve of cases of pneumonia without empyema and that of cases of pneumonia with empyema over a period of six years has shown a remarkable parallelism. This is interpreted as indicating that there is something in common between the two conditions which largely determines the death rate. This determining factor is probably the virulence of the micro organism. In this series all of the cases of empyema were treated according to a uniform plan which is described in the text.



The mortality curves of empyema and pneumonia by year periods

A, mortality rate in empyema by year periods, B, mortality rate in pneumonia by year periods (The mortality in pneumonia not determined for 1928, 1929 and 1930)

(Heuer: Acute Empyema, Vol 1 No 5 June, 1932, The Journal of Thoracic Surgery)

FIG 2—The mortality curves of pneumonia and of empyema as found by Heuer at Cincinnati

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recrudescence of the over-emphasis of details which appears from time to time. The explanation of the fact that the death rate in patients who develop empyema is lower than that of pneumonia in general probably is that the development of an empyema (an abscess) is indicative of a considerable amount of resistance against the infection.

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DISCUSSION.—DR. HOWARD LILIENTHAL (New York City) remarked that empyema usually originates from the lung. There is first a small sacculation that gets larger until at last there develops a single, large, sacculated empyema. There may, however, be a condition in which there are two, or three, or four, or even five empyemas that start not even simultaneously but at different times and in different parts of the pulmonary surface. If they run together, the ultimate result is a large sacculated empyema. If they do not run together one may open one sac at a time.

He had drained as many as five empyemas with fluid containing three different organisms at one time in a single patient, in a single hemithorax.

He also called attention to the fact that a general empyema is an exceedingly rare condition and it is one in which the lung is represented by a small collapsed mass on its root as a pedicle. This is a very serious condition and one which is extremely difficult to cure.

As to the matter of treatment, his way is closed drainage in one form or another. If the patient is not relieved at the end of four or five days an X-ray picture is made. That will probably show another pocket. The point is that empyema is not always a single sac or cavity. Correct treatment means constant watchfulness, frequent physical examination and enough X-ray pictures.

DR. J. M. MASON (Birmingham, Ala.) said that in the Children's Hospital of Birmingham, for a time closed drainage was much favored, but in a series of forty cases which were carefully analyzed, the conviction was evident that open operation by rib resection, performed at a time when the pneumonia had subsided, the pus had become thick, and the mediastinum had become fixed, was the simplest method of treatment and was followed by the lowest mortality.

Simplicity in after-treatment is very important. It is not necessary to irrigate the pleural cavity in children, or to confine them long to bed, as is the case when they are attached to suction apparatus or while being treated by other cumbersome methods of drainage. We have simply established tube drainage through a rib resection at the proper time, have allowed the secretions to escape on gauze pads frequently changed, and have allowed the patients to get out of bed and into the open air at an early date. They have been more contented and have improved more rapidly than have those who were treated by longer confinement. In this series of forty cases, the average time of tube drainage was 27.5 days.

DR. CARL EGGERS (New York City) said that the points which Doctor Graham had made are points which he emphasized in a paper in 1919 after the observation of a



group of empyema cases in one of the southern army camps (Empyema Analysis of Seventy Cases Surg, Gynec, and Obstet, p 348, April, 1919)

He went a step farther than Doctor Graham, and was able to divide the cases into those which followed a lobar pneumonia, and those secondary to bronchopneumonia. It became apparent to him that there is a great difference in the course and prognosis of empyema cases following lobar pneumonia and those following bronchopneumonia. The former is more likely to be a primary pneumonia, which attacks a patient suddenly, while the latter is more likely a secondary pneumonia, coming on after the patient is already weakened by some other disease such as measles, influenza, tonsillitis, or other infection. There is another important point to be borne in mind and that is the fact that lobar pneumonia is usually unilateral and often affects only one lobe, while bronchopneumonia is much more often bilateral and may affect all the lobes to some degree. This difference in cases is strikingly illustrated by the mortality in the two groups. While in the empyemas following a primary lobar pneumonia we had a mortality of only 12 per cent, it rose to 37 per cent in those cases following a secondary bronchopneumonia.

In addition to the type of pneumonia preceding their empyema cases, they studied them in relation to the organism responsible for the infection. They made the observation that even at that time, in 1917 and 1918, when empyema mortality was very high, there was a vast difference in cases depending on the organism concerned. In fifty-four cases due to the pneumococcus, there was a mortality of 17 per cent, while in sixteen cases due to the streptococcus, there was a mortality of 62 per cent. That was one lesson.

Soon after that he had another important lesson pertaining to the virulence of the organism in different parts of the country and at different seasons. In a southern camp in which they followed the same form of treatment in the influenza empyemas which they subsequently used in a western camp, they had a mortality of 27 per cent, while in the western camp epidemic, in which the same organism predominated, there was a mortality of only 6 per cent. (Relative Value of Various Operative Procedures Employed in Acute Empyema Jour Am Med Assn, p 995, October, 1920)

These various observations have made them feel that it is very misleading to draw definite conclusions from one group of cases. In making comparative studies in empyema it is important not only to consider the form of treatment employed, but to bear in mind the antecedent disease, the type of pneumonia, the organism concerned and its virulence, the prevailing climatic conditions, whether cases are sporadic or those of an epidemic, the age of the patients, and whether complications were present.

DR GEORGE J HEUER (New York City) remarked upon the studies which he had made based upon two large series of cases, a series in Baltimore which antedated the war, and a series in Cincinnati during the past ten years. It was shown conclusively, he thought, that the mortality in acute empyema depended much more upon the type of pneumonia which existed at the time and the presence and nature of other complications (lung abscess, pericarditis, septicæmia, etc) than it did upon the kind of operative and post-operative procedures which were employed, so long as the principles which Graham established were carefully followed. He asked Doctor Graham if he had made any observations on the healing of empyema cavities which support or refute the observations he had made. In a rather small series of cases he made accurate repeated measurements of the volume of empyemic cavities after operation, as a result of which he came to the belief that the healing of empyema followed the same laws which apply to the healing of superficial and deep wounds. In other words, the healing of empyemic cavities follows the law which Carrel and Du Nouv expressed in connection with the healing of superficial wounds. This means—if his observations are confirmed—that empyema heals in the same way as any superficial or deep wound and that the same principles should be applied in the management of empyema as are applied in the treatment of other wounds.

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DR ALEXIS V MOSCHCOWITZ (New York City) said that although primarily, he agreed with practically everything that Doctor Graham had reported in his paper, he could not fully agree with Doctor Heuer, provided he understood him correctly namely, that an empyema heals like any other wound. In the healing of an empyema, one is dealing with certain important mechanical principles and these differ materially from the mechanics of other healing wounds. In an empyema, one is dealing with a cavity, one boundary of which is absolutely rigid, while the other is also more or less rigid, but never soft and yielding. The Carrel-Dakin method of treatment he continued to use and the method continues to give him perfect satisfaction.

DR FRANK S MATHEWS (New York City) remarked that when the chest wall is opened and access of air permitted, the tendency of the lung must always be to contract and leave the chest wall as a result of the intrinsic elastic fibres of the lung. The lung itself can make no active contribution toward its own expansion to fill the cavity but that it does expand is the result of positive pressure in the trachea and bronchi which occurs with forced expiration or coughing. One often sees the lung during an operation expand with coughing so as to forcibly eject fluid to a distance through the thoracotomy incision. To maintain the expansion that intermittently occurs in forced breathing there is nothing so efficient as a wet pad of gauze over the opening. This in no way interferes with the outflow of air or pus from the pleural cavity but it acts as a very definite barrier to the entrance of air with inspiration. If the physiology of the method by which the lung expands is kept in mind there is less temptation to replace the wet dressing by a closed suction drainage which, if the tube becomes plugged, at once stops drainage and interferes with the expansion of the lung as there is no longer free exit for air and pus.

DR EVARTS A GRAHAM remarked as to the point which Doctor Heuer spoke about last, being able to prophesy the time of healing of the empyema cavity he had found to hold true pretty generally in cases of empyema.

The limitations of time had prevented his going into a discussion of the differences in organisms, the relationships to systemic disease such as measles, scarlet fever and so forth.

He had grouped together the mortality figures of pneumonia regardless of whether they were due to streptococcus or pneumococcus because he thought the figures would be more striking if they showed the same parallelism to the mortality of empyema as if he had divided them separately into different kinds of organisms.

# TUMORS OF THE BONY CHEST-WALL

A STUDY OF TWENTY-TWO PERSONAL AND SEVENTY-EIGHT

COLLECTED CASES SINCE 1921

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OF CHICAGO, ILL.

THIS paper is based primarily on the study of twenty-two personal cases and on seventy-eight collected from the literature since 1921. At that time I reported forty-eight cases from The Mayo Clinic and thirty-five collected from the literature. These added to 103 reported by Parham in 1898 and twenty-seven by Lund in 1913 make a total of 313 cases since the first thoracotomy for tumor recorded by Osias Ainar in 1778. In the study of this combined series the material collected by Parham, Lund, and Heuer who has made a study of twenty-seven cases between 1921 and 1926 has been especially valuable. Of the cases listed since 1913 the original records have been studied.

In this series, tumors of the soft tissues, including those of the breast, of the axillary glands, lipomata, hemangiomas, superficial dermoids, skin carcinoma, *etc.*, are excluded except for rare instances in which the bony thoracic wall was involved.

The dividing line between tumors that are primarily in the thoracic wall and those that involve it secondarily from within the thorax may be ill-defined clinically in some cases and the differentiation must then be somewhat arbitrary.

Of the total series of 313 cases twelve were metastatic to a lesion elsewhere. It would perhaps seem desirable to exclude all the secondary growths, but in some of them it has been impossible to recognize their secondary nature.

TABLE I

Pathological Classification	Collected up to 1921	Personal and Collected 1921-1933	Total
Chondroma	40	14	54
Fibroma	5	2	7
Osteoma—exostosis	3	2	5
Giant cell		1	1
Sarcoma	131	61	192
Carcinoma	24	12	36
Endothelioma		3	3
Myeloma		2	2
Lymphangioma		1	1
Lipoma		2	2
Gumma	1		1
Uncertain	9		9
Totals	213	100	313

## TUMORS OF CHEST-WALL

until operation or necropsy. These cases therefore seem of some value in the study of differential diagnosis. Some have been treated as primary growths with marked palliative results.

The classification of these tumors is that of the main pathological types and their subdivisions.

TABLE II

*Relative Incidence of Types of Tumors in 143 Cases*

Pathological Classification		Mayo Clinic and Present Series	
Chondroma	12	Fibrosarcoma	8
Osteochondroma	5	Lymphosarcoma	2
Fibroma	3	Angiosarcoma	1
Periostitis	3	Carcinoma	12
Osteoma	2	Epithelioma	1
Lipoma	2	Non-melanotic melano-epithelioma	1
Giant-cell tumor	1	Endothelioma	3
Sarcoma	58	Hypernephroma	5
Chondrosarcoma	7	Myeloma	1
Myxochondrosarcoma	2		
Osteochondrosarcoma	2		
Osteosarcoma	9		
Osteofibrosarcoma	1		
Fibromyxosarcoma	2		

It will be noted that of thirty-four cases in which the type of sarcoma was specified it was of the chondroma type in sixteen cases.

In 261 (80 per cent) of the 313 cases the tumors were of the ribs and in fifty-two (20 per cent) of the sternum. Of seventy cases of rib tumor fifty were sarcoma and ten chondroma. There was one sarcoma and one chondroma of the sternum. The others were all metastatic.

The location of the tumor in sixty-four cases in the present series was as follows:

TABLE III

	Right Side		Left Side		Total
	Sarcoma	Chondroma	Sarcoma	Chondroma	
Anterior	16	3	9	3	31
Lateral	10	3	7		20
Posterior	7	1	4	1	13
	—	—	—	—	—
Totals	33	7	20	4	64

In sixty-five cases the upper thorax was involved in twenty-one, the middle portion in fourteen, the lower in thirty, a single rib was involved in twenty, two ribs in fifteen, three or more in twenty-three, seven in one case. In thirty-two sternal tumors, the manubrium appeared chiefly affected in ten, the gladiolus in seven, the xiphoid in one. The exact location of the others was unspecified.

In sixty-five cases the size of the tumor was variously described as that of a nut, apple, fist, grapefruit, man's head, etc. In centimetres their approximate equivalents would seem to be as follows:

# CARL A HEDBLÖM

TABLE IV

	Sarcoma	Chondroma
Under 5 cm	5	5
6 to 12 cm	26	5
13 to 30 cm	21	3
	—	—
Total	52	13

TABLE V

*Age and Sex*

	1921 Series	Present Series	Total
Under 10	3	12	15
11 to 20	25	17	42
21 to 30	36	17	53
31 to 40	39	11	50
41 to 50	28	14	42
51 to 60	33	17	50
61 to 70	15	8	23
71 to 80	2	2	4
Not stated	32	2	34
	—	—	—
Totals	213	100	313

TABLE VI

	1921 Series	Present Series	Total
Males	116	59	175
Females	70	39	109
Not stated	27	2	29
	—	—	—
	213	100	313
Duration of the tumor			

TABLE VII

	Sarcoma		Chondroma	
	1921 Series	Present Series	1921 Series	Present Series
Less than 1 yr	38	24	6	3
1 yr to 6 yrs	60	15	12	4
More than 6 yrs	12	4	8	4
	—	—	—	—
Totals	110	43	26	11

*Etiology*—Among sixty-one cases of sarcoma in this present series there was a history of trauma in thirteen, among the fourteen chondromata, in six. In five of the sarcomata the time between the trauma and the recognition of the tumor was between two months and three years. Ewing postulates that five conditions must be fulfilled before a casual relationship between trauma and tumor can be justified. These postulations are (1) authenticity and

sufficient importance of trauma, (2) previous integrity of the wounded part must be established, (3) a reasonable time relationship of from three weeks to three years must exist, (4) the identity of the injured area with the site of the tumor must be established, (5) the nature of the tumor as established microscopically must be of a type that may be reasonably caused by trauma. Congenital tumors and lipomata are thereby excluded. In my case (VII) and in those reported by Harrington and by Morton, and in two cases by Becchini and in one by Zinniger these postulates seem fulfilled, except that the integrity of the part before the trauma usually cannot be proven. The fact that the male incidence of tumors is 60 per cent, and the further fact that 50 per cent occur on the more exposed anterior and anterolateral portion of the thorax suggests that trauma that has been forgotten may play a larger rôle than is apparent. Operative trauma seems to accelerate the growth of an incompletely removed tumor as illustrated in my Case I. The apparent tendency for sarcomatous degeneration of chondroma is suggested by the frequent occurrence of chondrosarcoma and by the finding of such pathology in tumors that have been present for years (Zinniger, Beck, Harrington). In one case in this series a sarcoma developed during pregnancy. Amburger and Tretze record such cases. In Tretze's case a tumor grew in three periods following three successive pregnancies during nine years.

The apparent accelerating effect upon the growth of chondroma of incomplete removal is well illustrated in Case VI and in others previously reported.

Of the malignant tumors other than the sarcomata, twelve were carcinomata, three endotheliomata, one myeloma. Carcinoma was primary in the thyroid in two, in the breast in four, in the lip in one, in the kidney in three, in the eye in one. (Melanoma.)

*Symptoms and Signs*—A swelling or bulging of the chest-wall or a definite mass is the most characteristic. Some degree of ache or pain is present in about half the cases. In many pain develops before there is any palpable or visible growth or bulging, as in my Case XIII and in those reported by Sourille and by Heurer. Busse records one case of myxochondrosarcoma which remained entirely intrapleural and which caused great pain, dyspnoea and finally the death of the patient.

Sarcomata are characterized by rapid growth and as the tumor enlarges, by a variety of other symptoms. Among sixty-one cases weight loss occurred relatively early in eleven, cough in eight, dyspnoea in six, cyanosis in three, pleurisy in three. Cord paralysis occurred in two and of the arm in one. Intermittent fever is not uncommon.

The pain may simulate other lesions. One of my patients with a tumor of the eighth rib was operated upon for gall-bladder disease because of pain localized in the right costal margin with spasm of the muscles.

Chondroma is usually of slower growth and as indicated in Table VII is of much longer average duration. The unreliability of pain in the differential diagnosis between sarcoma and chondroma is indicated by the fact that pain was present in nine of twenty-four cases of chondroma. The sudden onset

of pain in a previously symptomless tumor of long duration is, however, suggestive of malignant degeneration of a benign growth

A smooth surface is suggestive of chondroma, an irregular nodular one of sarcoma, but this is an unreliable criterion inasmuch as a chondroma may be nodular and at any time may develop malignant change

Röntgenological examination in a typical case of sarcoma or chondroma usually reveals a dense, well-defined shadow which may lie entirely outside the lung field or may encroach on it. In some the röntgenogram is negative (Cases I and XVII). The picture may be typical of an intrathoracic tumor and there may be a palpable tumor in case of one arising from the ribs and cartilages but projecting entirely into the pleural cavity. The pressure of a pleuritis with or without effusion may obscure the shadow even of a growth of considerable size

*Diagnosis*—In the presence of a large palpable tumor the diagnosis of a neoplasm usually is obvious but if the tumor is small or if it lies under heavy muscles or under the female breast (Turner) or if it extends chiefly or entirely intrathoracically it may be overlooked. Pain and other symptoms of mechanical origin may persist in any type of tumor and in other conditions

The differential diagnosis includes a consideration of inflammatory swelling, cold abscess, exostosis, gumma, aneurism, dermoid cysts, substernal thyroid and, in case of an intrapleural lesion, encapsulated effusion, pleuritis, or an echinococcus cyst. Inflammations associated with osteomyelitis or chondritis, sometimes with fever and pain, may simulate a tumor. In one of my cases there was secondary degeneration of the growth with abscess formation. A small cold abscess firmly encapsulated in a rib may not fluctuate. I have operated on one such case under the mistaken diagnosis of neoplasm. Exostosis may be impossible to differentiate as in several of my cases previously reported and in the instance of Zinniger. The Wassermann test and the classical findings of syphilis should always be sought for. Aneurism is suggested in some types of neoplasm by the presence of a true or transmitted pulsation

Aspiration by means of a small needle may be helpful but the finding of blood does not necessarily indicate aneurism nor does a dry tap entirely exclude it. In one instance I found an aneurismal sac partly filled with fibrin. Extrathoracic dermoid cysts of the thorax are rare. Intrathoracic dermoids in the anterior mediastinum, particularly those under the sternum or presenting in the neck of which there are (?) on record, are not unlike other neoplasms. Dermoids also not infrequently produce a bulge of the anterior chest-wall. A substernal thyroid usually but not always can be shown to be connected with the thyroid in the neck. I have operated upon one patient for intrathoracic goitre the size of a large orange under the mistaken diagnosis of a tumor. An encapsulated pleural effusion that simulated tumor can be differentiated by the aspirating needle

## TUMORS OF CHEST-WALL

The recognition of the metastatic nature of a tumor of the chest-wall following operation for breast cancer or in the presence of a malignant tumor elsewhere usually presents no difficulty. In some cases, however, the primary growth remains latent for some time until after the chest-wall tumor has attained considerable size. In one case in my series the patient had a cough and purulent sputum in which actinomyces were found microscopically. A large bulging tumor developed on the anterior chest-wall. Biopsy showed inflammatory tissue. The roentgenogram presented a typical, round, well-defined shadow characteristic of an encapsulated tumor. It was found to be encapsulated outside the pleura and was removed. Necropsy some weeks later revealed a primary pulmonary carcinoma. In another case, previously reported, a primary carcinoma of the adrenals was found at necropsy six months after the successful resection of a large encapsulated chest-wall tumor, showing histological findings characteristic of hypernephroma.

Careful study of the urine may show malignant cells in cases in which there is no blood (Macleod and Jacobs). I recently found a large hypernephroma in a patient whose urine had been consistently negative for several weeks.

The differentiation between benign and malignant primary growths can be made with assurance in some cases but in others it must be tentative only. A rapidly growing tumor is usually sarcoma, but one that has been present for years may show malignant degeneration, which is suggested by a sudden onset of rapid growth after long quiescence. Chondroma may, however show similar abrupt exacerbation of growth as in a case reported by Heuer. Such a chondroma is malignant in the sense that it occurs, metastasizes and kills the patient. Lipomata may recur (Stammmler) and may take the life of the patient if not removed (Walze). The finding of Bence-Jones protein as in one of my cases in this series is significant of myeloma.

*Treatment*—As in the case of tumors in general early diagnosis and radical extirpation offers the best prospect for a cure. If every tumor of the chest-wall is considered potentially malignant it will result in the removal of exostoses, hypertrophied cartilage, fibromata, *etc.*, in the pre-malignant stage and in case malignancy is already present the outlook is perhaps better at the expense of a much less extensive operation than that which may become necessary later. Chondromata removed early show a much less marked tendency to recur than those of long duration. Some, after years of indolence, abruptly begin to grow rapidly and then recur and metastasize soon after removal. Operative trauma seems to stimulate any residual tissue to such activity. It is therefore of the greatest importance that they be removed entirely and with wide margins of healthy tissue.

Sarcomata of the thoracic wall show the same tendencies to recur and to metastasize as those located elsewhere. The outlook as to permanent cure is bad but marked palliation may be expected in a large proportion following early operation, and in case of some, many years have been added to the patient's life.



Local recurrent carcinoma, particularly following radial operation for carcinoma of the breast offers a better prospect of palliation by radial resection of the chest-wall than the usual hopeless attitude towards them would seem to indicate. A fair proportion of the relatively few cases subjected to secondary radial operation have been free of further recurrence for years.

Palliation only is to be expected from radial extirpation of metastatic tumors but when the diagnosis of a primary growth elsewhere is uncertain it gives the patient the benefit of the doubt.

The value of radiotherapy as compared with radical extirpation of malignant tumors has not been determined. There is good evidence that it is of very definite value in some cases, in others it seems entirely ineffective. A judicious combination of surgery and radiotherapy probably promises the best results.

In case of primary growths the indications and contra-indications for surgical extirpation rest largely on the nature of the tumor and the general condition of the patient. The hazards of open pneumothorax of the earlier days have been largely overcome by the use of simple positive pressure anaesthesia and air-tight closure of the thorax after re-inflation of the lung. The residual air in the pleural cavity can be aspirated after closure by a pneumothorax apparatus.

The indications for the removal of a so-called "benign" chondroma or other non-malignant tumor are wider than for removal of a sarcoma, both with respect to the extent of the growth, and as to the condition of the patient. Often the nature of the tumor is in doubt until after its removal, but in cases border-line of operability, biopsy will establish the diagnosis before extirpation is undertaken.

The presence of metastases from a chest-wall tumor will usually contra-indicate operation, but the diagnosis of such metastasis may be erroneous as in a case reported by me in my earlier publication.

Infiltration and extension of the tumor beyond that recognizable clinically may be found at operation. In a number of such cases very extensive operations with resection of a large number of ribs have been reported, some with surprisingly good results. Some such cases will be referred to below.

In my own series of thirteen cases of sarcoma herewith reported five were subjected to radical resection, three had recurrence and two of these died within six months. Two had no recurrence, one and two years later, respectively. In the present series of sixty-one cases a radical resection was performed in thirty-five. One died of pulmonary embolism and two from uncertain causes shortly after operation. Nine were known to have died of recurrence, five within six months, one in ten months, two between one and two years, and one after four years. Of the remaining twenty-three, seven were without recurrence under six months, three between seven months and one year, three between one and two years. Speed's<sup>41</sup> patient was free of

recurrence four and one-half years. Three were living but had shown recurrence, two under six months, one over one year. The fate of six after leaving the hospital was not stated. Lockwood's patient is here recorded as having a recurrence within one year but this was following a third operation for recurrence. He lived between three and four years from the time of the first operation. It will be noted, therefore, that of the whole group subjected to radical operation eight are known to have lived from one to four and one-half years following it.

Among sixty-five cases of sarcoma previously reported fifteen (23 per cent) were known to have been free of recognizable recurrence one year or more after operation. One patient in The Mayo Clinic series was symptom-free for eight and one-half years. One patient in the same series presented himself with a recurrence after four successive operations performed thirty-two, eleven, two and one year previously.

In Parham's series of twenty-five sarcomata, eight (33 per cent) were reported free of recurrence for one to five years.

Palliative excision was done in eight of the sixty-one cases. One patient who had had a slow-growing tumor for fourteen years, sarcomatous at operation, was reported free of recurrence two years after local excision and cautery. Another lived one and one-half years after local excision.

Radiotherapy in the form of Rontgen-ray or radium treatment or both in various dosages was used together with operation in a considerable proportion of the cases. It is naturally impossible to evaluate its effect under such conditions. In most of the cases in which radiotherapy was the sole method of treatment, the results are not given. Goulhard<sup>12</sup> has reported one patient treated with radium alone living and free of recurrence for four years. Becchini<sup>2</sup> had one treated by radiotherapy alone who died of recurrence after twenty-eight months. Speed states that his patient, who is living and symptom-free after four and one-half years, and has since borne two children, had had no radiotherapy at any time.

Of fifteen patients subjected to biopsy alone, or with some radiotherapy, six were reported to have died within six months.

Among six cases of chondroma in my series five were subjected to radical operation and all remained free of recurrence from one to two years. One who had had two previous resections elsewhere, and on whom I did a palliative resection only, followed by massive radium treatment, was reported by her family physician to have developed further recurrence a few months later.

In one case at The Mayo Clinic I resected the whole sternum with part of the costal cartilages for an extra- and intrathoracic recurrent chondroma the size of a large coconut. The patient was in extremis with dyspnoea and cyanosis. He survived the operation surprisingly well but died about a week later with symptoms of cardiac exhaustion from respiratory embarrassment apparently due to the abnormal mobility of the chest-wall on both sides. It

seems likely that he might have survived had it been possible to splint the ribs or if a Drinker respirator had been available

Of the eight cases in the collected series seven were subjected to radical excision. Recurrence developed in the case of a huge substernal chondroma reported by Heuer in which he resected the lower two-thirds of the sternum with a tumor measuring ten by ten centimetres and with brilliant immediate result, but recurrent nodules were found at a second exploratory incision a few months later. One case of rib chondroma reported by Nigst,<sup>32</sup> with successive involvement of four ribs posteriorly, had not been operated upon at the time of his report.

At the time of my earlier series of thirteen personal and collected cases there was no known recurrence but one patient developed a recurrence after six years.

Among the cases of malignancy aside from sarcoma there were two radical resections for primary endothelioma (Harrington). One patient died four months later, one was free of recurrence six months after operation. There were three instances of radical resection of the chest-wall following recurrence after radical breast amputation for carcinoma. One died seven months later of metastases, one lived one year after the second operation for recurrence which was nine years after the breast amputation, one was living without recurrence seventeen and one-half years after the breast amputation (Denk). Several successful cases are cited in my earlier publication.

Nordenfelt records one resection of the chest-wall for carcinoma but does not give the site of the primary growth. There were evidences of metastases four months later.

In case of the metastatic growths from hypernephroma and malignant thyroid no radical resection was attempted.

All the benign tumors listed were successfully removed. The giant-cell tumor in my series of the eighth rib is the only one I find recorded involving the ribs. The patient is well eleven and one-half years later.

An extrapleural and intrapleural lipoma weighing 400 grams successfully removed by Walze in an infant five months old represents a truly lifesaving achievement. The periosteal lipoma removed in two stages by Stammli, and which recurred but disappeared following radiotherapy, is another unusual type of chest-wall tumor.

**SUMMARY**—(1) Tumors of the bony chest-wall are relatively rare. Among 313 cases, including twenty-two herewith first reported, about 17 per cent were chondromas and 5 per cent benign growths, about 61 per cent were sarcomas and 13 per cent other malignant neoplasms. Nine were of uncertain type. The ribs were primarily involved in 80 per cent, the sternum in about 20 per cent.

(2) Trauma seems to be etiological in an uncertain proportion of chondromas and in both primary sarcomas and chondrosarcomas.

(3) Pain is the most characteristic symptom of both chondromatous and sarcomatous tumors. It may develop before a mass is recognizable clinically or roentgenologically.

## TUMORS OF CHEST-WALL

(4) Aspiration or biopsy may be necessary to exclude other lesions and to establish the nature of the tumor

(5) Early radical extirpation offers the best prospect of a cure Late operation, even in the presence of an extensive spread of a malignant growth, may result in prolonged freedom from recurrence

(6) Exploratory thoracotomy may be indicated in case of doubtful operability

(7) Positive pressure anæsthesia largely removes the immediate risk of open pneumothorax and re-inflation of the lung before closure lessens the liability to post-operative respiratory embarrassment and to late pleural complications

(8) Operability can be extended by a graded operation

(9) Recurrence may develop following operation for chondroma and is the rule in sarcoma but life may be made more comfortable and may be much prolonged and there is a possibility of a cure

(10) In view of the added safety of radical operation afforded by modern methods increased consideration should be given to radical resection of the chest-wall for the relative frequent local recurrence after amputation of the breast for carcinoma

### CASE REPORTS

CASE I—L. N. G., female, aged sixty-one, came to The Mayo Clinic November, 1922, because of a recurrent tumor over the sternum

Seven months before, a tumor two to three centimetres had been excised from the sternum The pathological diagnosis was chondroma Four months later a recurrent tumor was removed A second recurrence developed during the succeeding three months

On examination an indefinitely outlined, hard, non-tender mass was noted over the lower sternum and left costal cartilages and apparently fixed to these structures The physical examination otherwise showed normal findings The urine showed a few pus cells only Rontgenogram of sternum showed normal findings

At operation an irregular hard tumor mass was found involving the fourth left costal cartilage and extending down below the normal level of the cartilage perhaps a centimetre and extended along the sternal margin about to the junction of the gladiolus with the manubrium The tumor was removed with a curette and by sharp dissection from the sternal margin where it was attached to the periosteum and the whole area was then thoroughly cauterized with the actual cautery Three fifty-milligram tubes of radium were then placed in the cavity and the wound was closed, leaving the threads attached to the radium outside She was dismissed in good condition on the eleventh day

The operation was considered palliative only and the prognosis poor The patient and family had decided against a radical resection of the sternum because of the risk involved and because no assurance could be given of a cure following it

A month later the patient received a second radium treatment

Two months after this her family doctor reported that there was some necrosis from the massive irradiation and that there was evidence of recurrence both laterally and under the sternum

CASE II—Female, aged thirty-eight, entered The Mayo Clinic April 19, 1922, because of a tumor of the eighth rib posteriorly discovered on a rontgenogram

In 1907, she injured her back in a fall and was confined to bed for a week for this injury She had no further symptoms referable to this episode until in the Spring of 1919 when she developed a constant severe knife-like pain in her left side from the back

to the breast which prevented sleep. The eighth intercostal nerve had been sectioned with complete relief of the pain for three months but it then recurred as severe as before but limited to the back as far as the axilla. She could not lie on her back or right side. In November, 1921, a roentgenogram showed an irregular elongated tumor of the eighth rib. She had had an hysterectomy for "fibroids" and appendectomy in 1908.

Examination revealed tenderness over the dorsal spine and laterally at the level of the seventh, eighth and ninth ribs but no other abnormal findings. Roentgenogram showed a destruction of the proximal end of the eighth rib on the right. The differential diagnosis lay between giant-cell tumor and sarcoma with the possibility of chondroma, myeloma or hemangioma. The patient went home and returned May 18, 1922, for operation.

At operation the proximal end of the rib was found to be enlarged to three or four times its normal diameter. It was very friable and very adherent to the surrounding structures, and extended from the articulation with the transverse process outward about seven centimetres. The rib was sectioned well beyond the tumor area and enucleated from its articulation with the transverse process and spine. The wound was closed in layers. The specimen was seven centimetres long and two and one-half centimetres in breadth and thickness and showed practically complete disorganization of the bone. The pathological report was giant-cell tumor.

The convalescence was complicated by a bronchopneumonia of severe grade with delirium, but with complete recovery. She was discharged with wound healed and in good condition on the twenty-first day after operation.

In April, 1924, the patient reported that X-ray showed no evidence of recurrence.

In April, 1933, seventeen years after operation, her physician reported that the roentgenogram showed regeneration of bone at the site of operation, but Doctor Bloodgood who examined the plate expressed the opinion that it was not a recurrence.

CASE III—L. M., male, fifteen years of age, entered Augustana Hospital in February, 1926, because of a swelling in the right side, and was referred by Dr. Anders Frick. About nine months before admission, some weeks after a severe blow in the right chest he first noticed occasional dull aching pain in the right chest just above and to the outside of the nipple. About five weeks before admission he first noticed a small lump in this area which had grown considerably since. One night two weeks before admission he was awakened from sleep by an acute stabbing pain in the region of the tumor.

On examination a sausage-shaped tumor about four centimetres in transverse diameter and raised about one and one-half centimetres above the surrounding area was found in the region of the fourth rib in the mid-axillary line and extending backward under the scapula. It appeared firmly attached to the deep structures but the skin which appeared normal and moved freely over it. The boy was pale and thin. The thyroid gland was symmetrically enlarged and he had definite tremor of the hands. There was a widely transmitted mitral systolic murmur. The pulse was 88, temperature 99.4°. The hæmoglobin content of the blood was 75 per cent. Roentgen-ray examination showed a dense shadow in the region of the tumor encroaching considerably on the lung field. The pre-operative diagnosis was sarcoma of the chest-wall.

February 8, under local and nerve-block anaesthesia through a curved incision from the sternum to the posterior axilla the flap including the pectoralis muscles, the tumor was exposed. The tumor was found to involve the fourth rib and to completely fill the adjacent intercostal spaces and to extend from near the costochondral junction beyond the vertebral border of the scapula. Because of its extent and the relative poor condition of the patient it was considered inadvisable to attempt complete removal in one stage. The fourth cartilage and the third and fifth ribs were resected as far proximally as accessible. The non-adherent lung was sutured to the chest-wall with catgut and the wound closed.

One week later under nerve-block anaesthesia through a paravertebral incision the remaining proximal segments of the third and fifth ribs and the fourth to within three

centimetres of the tumor were resected and the lung sutured to the chest-wall in this area

One week after the second stage under positive-pressure gas anaesthesia the flap made at the first operation was turned up and the previously mobilized tumor mass was removed with intercostal tissue and parietal pleura. The lung did not collapse because of the pleural adhesions but there was a little air aspirated through a leak at one point.

The convalescence throughout was uneventful. There was no pleural effusion.

The boy was discharged in good condition about four weeks after the first operation. During the next two months he received several deep X-ray treatments under the direction of Dr Henry Schmitz. He gained in weight and strength. During the third month he began to lose weight and developed pain in his right chest and the roentgenogram showed findings suggestive of recurrence.

An exploratory intercostal thoracotomy was performed June 17. A soft pulpy tumor mass was scraped out of a large intrapleural cavity and the wound closed without drainage. He returned home June 28 and died a few weeks later.

CASE IV—A W, male, aged four, came to the clinic August 1, 1921, because of a recurrent tumor of the left lower chest-wall, which was a recurrence of a tumor removed three months before elsewhere. The tumor was first noticed a year before admission which grew to the size of a hen's egg at the time of the operation a month ago. The doctor who removed it thought it was a lipoma but the biopsy of the tumor showed sarcoma.

His parents brought him to the clinic three months before this time, one month after the first operation. Examination at that time showed no tumor. He was given X-ray and radium treatment and discharged.

On examination at the second visit a tumor mass was felt over the lower anterior aspect of the left chest, which seemed fixed to the ribs, but the skin over it was freely movable except in the centre under the scar of his former operation. A Wassermann test was negative. The blood haemoglobin showed 66 per cent.

At operation the eighth, ninth, tenth, eleventh and twelfth ribs were resected through a curved incision along the lower half of the circumference of the tumor. The tumor mass was found to involve the ninth, tenth, eleventh and twelfth ribs. The tumor mass was dissected from the peritoneum bluntly and lifted upwards. The pleural reflection at the costophrenic sinus was now sutured to the intercostal tissues below the excised eighth rib to the diaphragm. In this way the pleural cavity was walled off so that there was no pneumothorax. Tumor was then entirely removed and the wound closed without drainage. *Pathological Report*—Sarcoma.

Patient's convalescence was marked by rather high pulse rate for the first few days and some temperature. He was discharged on the fifteenth day after operation, after having received radium treatment. Two months later when he was brought back for further radium treatment a recurrence was noted on the left chest-wall but he seemed well and very active and had lost no weight. He was given further radium treatment. January 31, 1932, he returned for another treatment and his mother stated that the tumor present in November had promptly disappeared but two weeks ago two other masses were noticed. On examination at this time, January 31, four distinct tumors were felt on the left anterior chest-wall, for which more radium treatment was given. February 3, a secondary operation was done and two encapsulated tumors, one four by two and one-half centimetres, one three by five by seven centimetres, were enucleated. These masses were not adherent to the peritoneum. The peritoneum was opened in dissecting them out. The third mass over the anterior ends of the cartilages of the seventh, eighth and ninth ribs, was about two by one-half centimetre. The beds of the ribs were cauterized with the electric cautery and the patient given further radium treatment. He was dismissed from the hospital on the sixth day and was given further radium treatment. The average dosage of the radium was from 9,000 to 12,000 millicurie hours each treatment. About six months later his father reported that he had developed further recurrences and had died.

CASE V—A M, male, aged seventy, came to the clinic March 6, 1922, because of swelling and pain in the left chest Six years before he had been struck by a bull in the left chest The swelling was painful most of the time On examination a mass was found on the left chest-wall oval in shape six by six centimetres in diameter It was painful to pressure, the veins over the tumor dilated Rontgen-ray showed a shadow over the second and third ribs anteriorly on the left

At operation a tumor mass which was soft, very vascular, somewhat expansile was found over the second and third ribs The second, third and fourth ribs were separated proximally and distally to the tumor About fifteen centimetres of the fourth rib were resected The pleura was not adherent The lung was sutured to the intercostal tissue by continuous chromic catgut sutures The wound was closed without drainage Ten days later the wound was opened up and the tumor removed with the ribs and intercostal

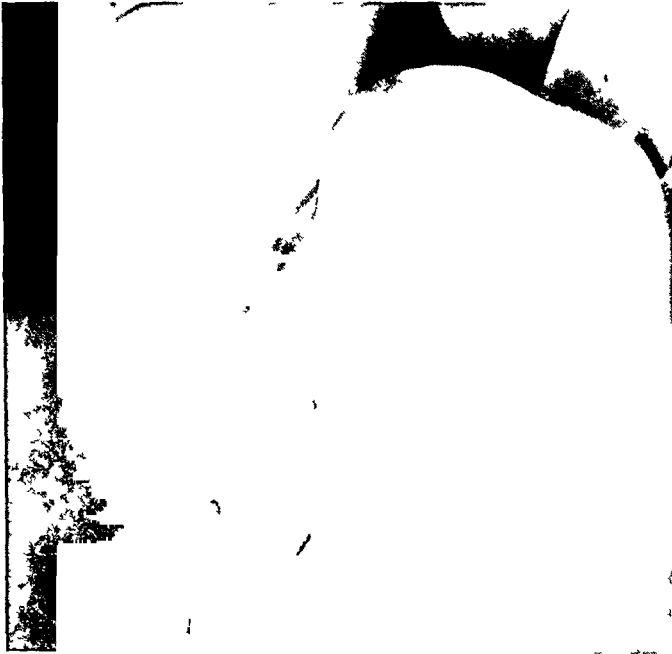


FIG 1—Tumor of left upper anterior chest wall Photograph taken following first stage operation

tissue and pleura There was small pneumothorax collapse from leakage at one point but this caused the patient no symptoms He was discharged three weeks after the operation in good condition after having received a course of radiotherapy Six months later he returned for further radiotherapy There was no evidence of recurrence at that time

CASE VI—J G, male, aged thirteen, came to the Research and Educational Hospital October 25, 1927, because of a lump in his left anterior chest-wall He first noticed a mass there two years before, a few months after an injury in this region It had been removed in June, 1927

On examination a mass about five centimetres in diameter was felt over the eighth left rib in the mid-axillary line where there was a linear scar from his former operation Physical findings were otherwise not noteworthy Rontgenological examination showed the findings of a tumor located outside the pleural cavity At operation the mass was found to involve the eighth rib only in an extent of about six centimetres in its long diameter and was about four centimetres in transverse diameter The tumor was removed with the periosteum and about five centimetres segment of apparently sound rib proximal and distal to it Microscopical examination showed fibrosarcoma

## TUMORS OF CHEST-WALL

January 14, 1929, he returned because of a second recurrence of the tumor. He also complained of soreness in his left abdomen and groin. Physical examination at this time showed an irregular oblong mass of about the same diameter as before. The röntgenogram showed a diffuse shadow laterally and there was a shadow at the apex of

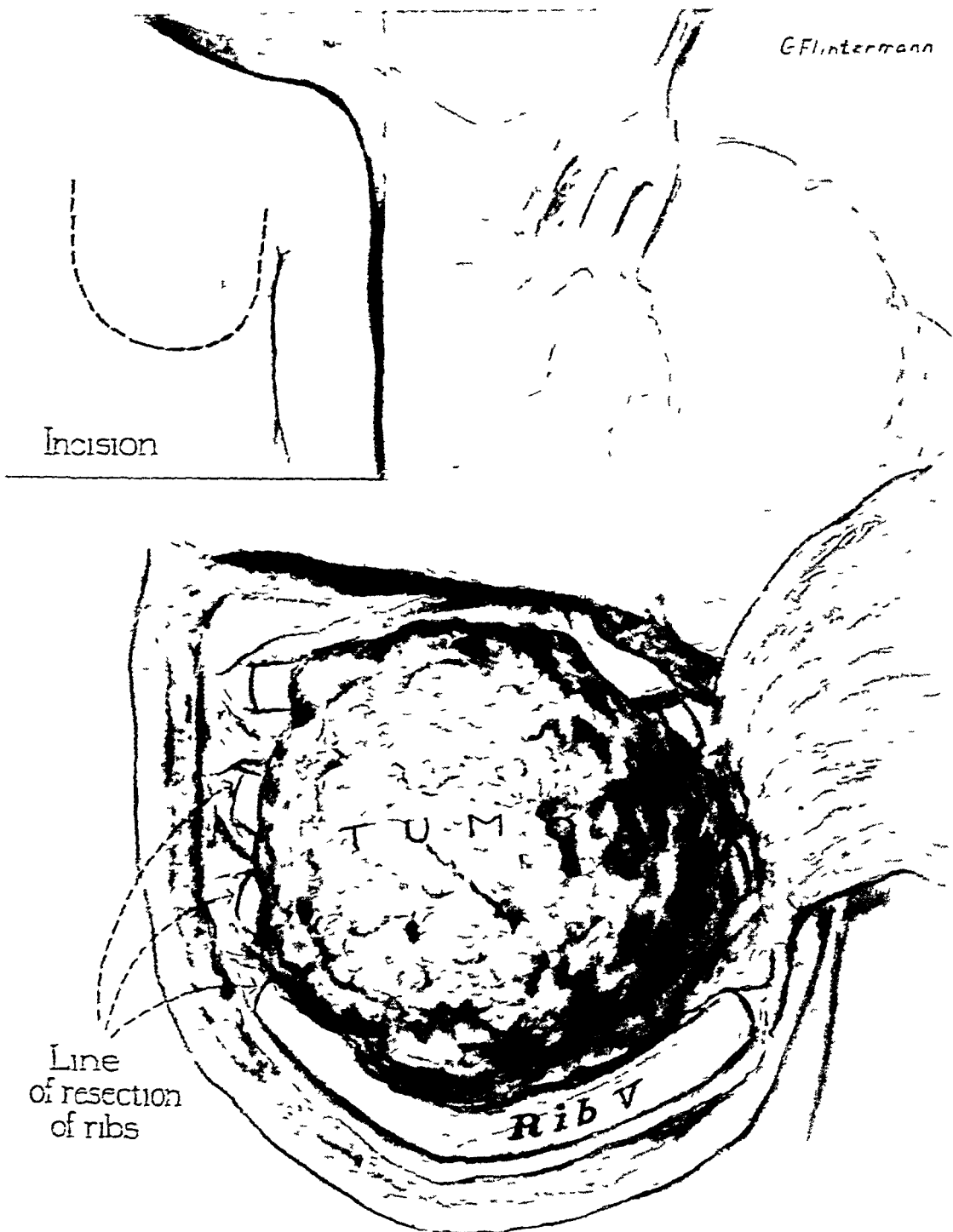


FIG 2—Drawing showing section of second, third and fourth ribs, first stage operation

the left lung which Doctor Hartung considered to signify a possible pulmonary metastasis. The tumor mass, irregular in outline, about five centimetres in its longest diameter but which showed no evidence of having involved the adjacent ribs, was removed with all adjacent tissue down to the pleura. The pathological diagnosis was giant-cell type of osteogenic sarcoma.



During the following months he received a number of Rontgen-ray treatments

When last seen three years after the second operation there were no signs of recurrence

CASE VII—F D, male, aged thirty-seven, in February, 1932, was thrown from a wagon in a collision with an automobile and sustained a fracture of both bones of the right leg About five months later he first noticed soreness and a swelling of the left anterior chest-wall (Fig 1) which has gradually increased in size during the eight months that had elapsed before the examination which revealed a hard mass about seven to ten centimetres in diameter and elevated about three centimetres above the other side It felt smooth and fixed to the ribs X-ray showed a loss of substance of the third left rib near the costocartilaginous juncture The diagnosis was osteochondroma



FIG 3

FIG 3—Specimen removed at second stage operation The pleura were adherent but not involved in the tumor Pleural cavity not opened



FIG 4

FIG 4—Microphotograph Same case as Fig 3

The tumor involving the second and third ribs (Fig 2) was removed by a two-stage operation At the first operation under local and nerve-block anesthesia the third and fourth ribs which were involved in the tumor were resected proximally and distally to the tumor and about twelve centimetres of the fifth which was not involved was resected subperiosteally The lung was not adherent An iodoform gauze pack was placed against the parietal pleura and the wound closed without drainage

At the second operation two weeks later the tumor was removed without opening into the pleural cavity (Figs 3 and 4) The tumor was about eight centimetres in diameter Microscopical examination showed osteochondroma The convalescence following both operations was uneventful

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DISCUSSION —STUART W HARRINGTON, M D, of Rochester, Minnesota, remarked that tumors, particularly those which originate in, or which involve, the thoracic wall, often present greater technical difficulties than those that are entirely contained within the thoracic cavity This is particularly true in relation to the technical problem of reconstruction of the thoracic wall following removal of large growths which involve it

He preferred an operation in one stage when possible He had removed these growths by operations in multiple stages, but in many instances had found that the second stage was more difficult technically, and more hazardous to the patient Many of these growths are so situated that the operative procedure cannot be satisfactorily interrupted for performance in stages, and though the risk may be considerable it is best to complete the operation at one sitting When growths involve the thoracic wall close to the diaphragm, or the thoracic wall and the diaphragm, the defect in the thoracic wall and diaphragm often can be closed by utilizing the paralyzed diaphragm after phrenicotomy When growths involve the posterior wall the scapula can be utilized to cover large defects, with no marked limitation of its function

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When tumors involve the anterior thoracic wall, and this refers particularly to chondromas which project into the pleural cavity, he preferred to remove the tumor from the pleural side, by a posterior intercostal incision after allowing the lung to collapse. The posterior approach entails less disturbance of the thoracic wall and allows more secure closure of it. In one case, he had had pulmonary hernia result from extensive anterior resection of the thoracic wall. This is prevented by the posterior approach.

The large majority of primary tumors of the thoracic wall are malignant. In his experience of forty-three cases, approximately 85 per cent of the tumors were malignant, and he thought that all were potentially malignant. The results from operation on benign tumors are very good, but the results in cases in which the tumors are malignant are not so satisfactory, for the tumors usually are of an infiltrating type and of a relatively high grade of malignancy. The average length of life following operation for malignant tumors has been about two years, although he had one patient with osteofibrosarcoma who is living and well more than six years following operation.

DR WILLIAM B. COLEY (New York City) recalled Doctor Lilienthal's case of mediastinal sarcoma which was reported before the New York Surgical Society in 1916 (see *ANNALS OF SURGERY*, April, 1927), and with his permission showed some lantern slides of it. The patient, a little girl aged two years, was brought to the Clinic of the Hospital for Joint Diseases, March 21, 1924, with the following history. At the age of five months the mother noted that the child's breathing was distinctly labored but nothing wrong with the lungs could be found. At the age of eight months a lump "on the right shoulder blade" appeared. An X-ray picture was taken at the Babies' Hospital, and reported on as follows: "A large, roughly quadrilateral dense shadow in the lower part of the right chest extending over the heart, also into the left chest and down over the liver shadow."

At the age of twenty-one months the child suddenly stopped walking because of weakness of the right lower extremity. This became rapidly progressive. At the time of Doctor Lilienthal's examination on April 12, 1924, both legs were flaccid and obviously paralyzed. There was a protruding subcutaneous mass covered with normal skin between the right scapula and the spine. X-ray examination showed a large mass in the right chest extending across the median line into the left chest above the heart. There appeared to be partial erosion of the adjacent ribs posteriorly and also some erosion of the bodies of the neighboring vertebra. On April 15, Doctor Lilienthal performed a posterior thoracotomy, removing a considerable amount of soft, grayish-red neoplastic tissue. This was examined microscopically by Dr. F. S. Mandlebaum who pronounced it an angiosarcoma. Sections were examined by Dr. Louis Gross, also, whose diagnosis was that of hemangio-endothelioma. In the opinion of Doctor Ewing it was a very malignant cellular tumor of embryonal type.

On April 25, 1924, the patient was put upon Coley's toxins. The family physician, started with a dose of 1/25 minim, and increased this gradually until on the eleventh day a dose of 4 1/2 minims was reached. Rather severe reactions followed. Three weeks after the operation, the child began to walk. The X-ray pictures showed gradual disappearance of the tumor, the one taken on October 16, 1926, revealed a normal chest. The child made a complete recovery and was in excellent health when he presented her to the members of the American College of Surgeons in October, 1931 (seven and one-half years later), and to the staff of the Memorial Hospital in the fall of 1932 (eight and one-half years later). In this case (1) The tumor involved both bone and soft parts. (2) The disease was so far advanced that the patient was nearly moribund at the time the treatment was begun. (3) The short duration of treatment, only eleven doses of toxins. (4) Coley's toxins alone were used, no other treatment. (5) The patient made an immediate and rapid recovery and was still well eight and one-half years later.

# COMPLICATED CONTRACTURES OF THE HAND, THEIR TREATMENT BY FREEING FIBROSED TENDONS AND REPLACING DESTROYED TENDONS WITH GRAFTS

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*The hand of the working man is his most valuable asset. Without it life becomes a burden*—Kanavel<sup>27</sup>

THE restoration of function in a finger or hand rendered useless as a result of injury or infection frequently appears a hopeless task, and yet the function of the hand is so important to the patient that one is justified in considering very seriously every method that offers a possibility of bringing about the desired result. The importance of substituting normal skin and subcutaneous tissue for firm and extensive superficial scars before carrying out operative procedures on the deeper structures of the hand and forearm, of uniting divided nerves and bringing divided tendons into end-to-end apposition when this can be accomplished, and of mobilizing stiffened joints of fingers or wrist by extra-articular operation, by arthroplasty or by splinting and well-directed physical therapy, or by a combination of these methods, is well recognized by every surgeon who is interested in the reconstructive surgery of the hand. In many cases of complicated contracture replacement of superficial scar tissue by a flap of normal skin and subcutaneous tissue and mobilization of stiffened joints must be carried out as the first and second steps in the reconstructive process\* and in many cases nerve suture may also be an essential part of the operative treatment. Without further consideration of these important and accepted methods of treatment we wish to pass on to the discussion of two methods that we have found of value in the treatment of seriously injured hands—freeing of fibrosed tendons, and substitution of tendon grafts for destroyed or hopelessly injured tendons or to fill the gap between the markedly retracted ends of divided tendons.

We would be the last to infer that this problem is a new one or that it has not previously attracted thoughtful study and serious consideration. Some of the ablest minds of the surgical profession in our own country and abroad have devoted careful clinical and experimental study to its solution. The work of Kanavel,<sup>6</sup> Bunnell,<sup>6, 7</sup> Mayer,<sup>25, 26</sup> Steindler,<sup>27</sup> Lyle,<sup>22</sup> Lewis,<sup>21</sup> Auchincloss,<sup>1</sup> Taylor,<sup>29</sup> Cleveland,<sup>8</sup> Garlock,<sup>9, 10, 11</sup> Mason,<sup>23</sup> and Iselin<sup>12</sup> is

\* "Joints must be mobilized before tendons are repaired or no motion will result. We cannot expect a newly repaired tendon to move a stiff joint, nor should we repair a bone and at the same time a tendon or joint. The former demands post-operative immobilization, and the latter mobilization." (Bunnell<sup>6</sup>)

## CONTRACTURES OF THE HAND

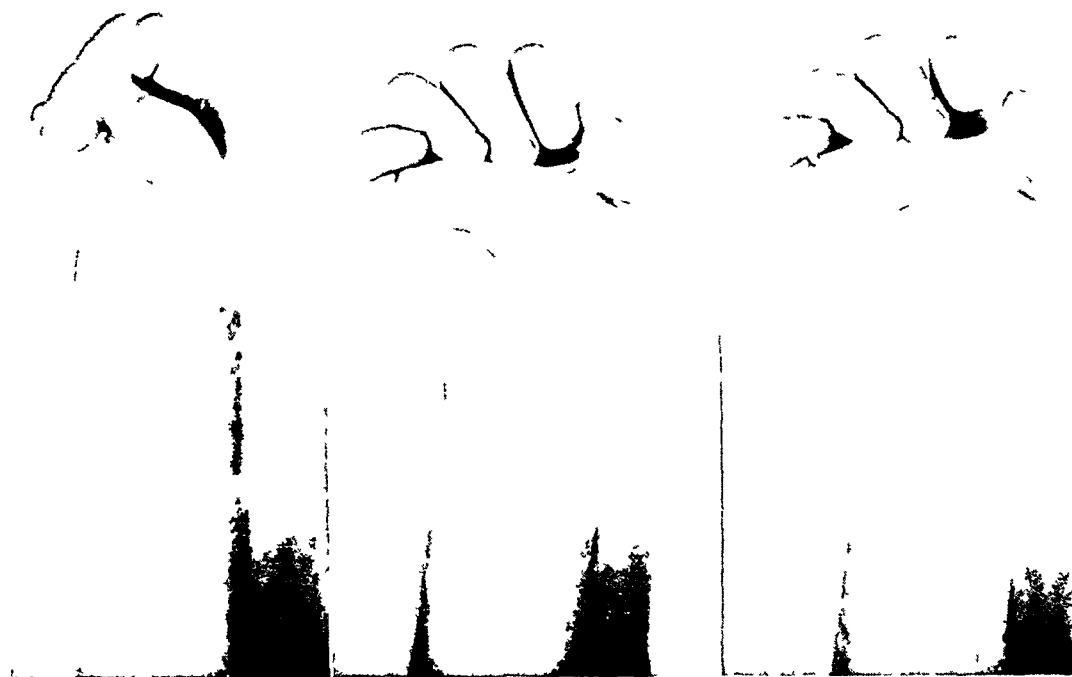


FIG. 1.—Flexion contracture of fingers and thumb secondary to an acute spreading infection of the hand and forearm. The fingers are almost completely fixed, a very slight movement of the thumb away from and toward the index finger are the only movements possible. There is a complete ankylosis at the wrist joint. Healing is still too recent to permit operative interference without danger of lighting up a latent infection.



FIG. 2.—Limits of extension (a), and flexion (b), in the hand and wrist of a fifty one year old physician two and one-half years after an acute spreading infection following a needle prick of the thumb sustained during a surgical operation. (c) Fixation of thumb in adducted position.

too well known to require a detailed discussion of their several contributions. The papers of Kanavel<sup>13, 14, 15</sup> upon infections of the hand and the treatment of their sequelæ have come to be recognized as outstanding contributions to American surgery. In any discussion of the subject of tendon grafts the pioneer work of Bunnell must be acknowledged at the very beginning. No one has done more to perfect the details of operation nor has obtained more beautiful results than he has shown in his several and excellent papers on the reconstructive surgery of the hand and the surgery of the nerves and tendons of the hand. In our own work we have borrowed freely from each of those mentioned and have tried to adapt the helpful ideas they have suggested to our own particular problems.

#### FREELING OF FIBROSED TENDONS

The hand with rigid motionless fingers, often shiny from trophic changes and wasted from disuse, at times almost fixed as though cast in iron, is a familiar object to the surgeon interested in the surgery of the hand\*. In such a hand the fingers may be fixed in flexion (Fig 1), a position identical with that seen in von Volkmann's ischæmic contracture, and there may be in addition a complete ankylosis at the wrist-joint, the fingers may be extended with the thumb extended and lying alongside the palm (Fig 2), if there is associated median- and ulnar-nerve injury the fingers may be held in semi-flexion at the interphalangeal joints and in hyperextension at the metacarpophalangeal joints (Fig 3). In less seriously injured cases the fibrous-tissue fixation may involve

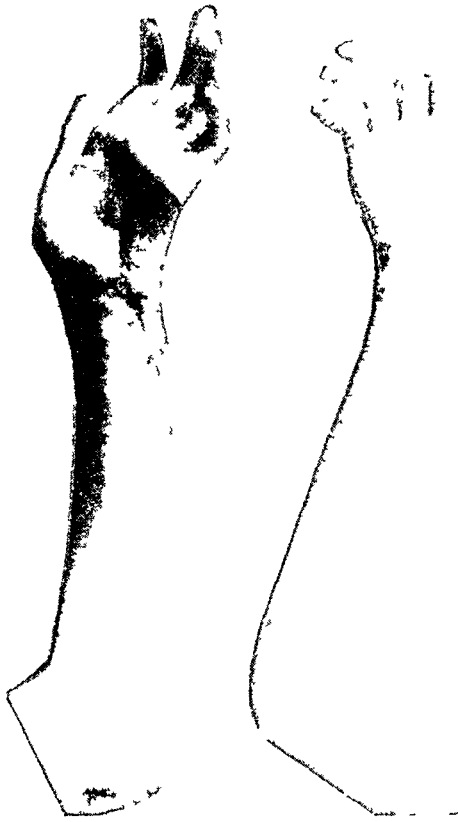


FIG 3—Typical contracture following an injury of flexor tendons with division of median and ulnar nerves

several fingers only, or even a single digit. No matter in what position the fingers have become fixed as a result of the initial injury or infection or how extensive the involvement, these cases have one common characteristic—loss of the ability of the tendons to glide freely through their normal range of move-

\* "One sees a glossy skin with atrophied hypothenar, thenar, and forearm muscles and shrunken intermetacarpal spaces, the thumb frequently abducted and fixed, the fingers flexed upon themselves and extended on the hand, with fibrous ankylosis of the finger-joints, and frequently osseous ankylosis at the wrist-joint producing an immobile, shrunken, claw-hand, absolutely functionless and useless. Moreover, owing to the poor nerve and blood supply, the hand is often the seat of ulcers, frost-bites, and inadvertent burns" (Kanavel<sup>16</sup>)

ment \* This may be due to fixation of the tendons in a limited area, it may be due to a fibrosis involving the entire length of the tendons, and in cases of long standing or after a severe spreading infection fibrosis of the muscle bellies, with its resulting limitation of muscle contraction and relaxation, may add an additional handicap to the normal movement of the tendons

It is obvious that after infection about a tendon or within its sheath, or after the extravasation of serum and blood-cells which follows an injury, the resulting scar-tissue formation is most marked and damaging at the sites of greatest constriction, where the exudate is held under tension in a limited space, and where tendons lie close to one another in definitely limited tunnels or compartments † These sites are within the digital flexor sheaths and underneath the transverse carpal (anterior annular) ligament on the volar surface of the hand and wrist, and in the various compartments underneath the dorsal carpal ligament on the dorsal surface of the wrist In certain cases the limiting fibrosis may be confined to one of these areas In others, in which a panniculitis of hand and forearm has been present, both flexor and extensor tendons may be bound in scar tissue throughout almost their entire extent No matter how limited or extensive the scar-tissue formation, improvement of function depends upon the completeness with which the tendons can be freed from its vise-like grip ‡

In certain cases, as suggested above, an additional factor which also affects the movement of the tendons must be considered If the contracture follows a severe spreading infection in which there has been extensive involvement of muscles as well as tendons, and if the fingers have been kept motionless in extension during the period of acute infection, the flexor muscles become fixed in a relaxed position If after their tendons have been freed such

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\* We do not mean to imply that the loss of the ability of the tendons to glide freely is the sole cause of the disability but that it is a constant factor in the types of cases under discussion The periarticular fibrosis and fibrous contraction of joint capsules which follow infection and long-continued immobilization often constitute another important factor in the disability, but, as stated above, the present discussion is confined to the part played by the involvement of the tendons

† "The infection has followed the paths of nerves and blood-vessels and the resulting scar contraction has so strangled them that the tissues supplied have become atrophic and congealed The greatest damage is done in the closed spaces, as under annular ligaments, in the tendon sheaths and in the fascial spaces, where swelling is limited and necrosis, from both ischæmia and infection, results" (Bunnell<sup>5</sup>)

‡ "The first endeavor should be to find the median and ulnar nerves in the forearm and trace them into the palm The nerves are dissected out of their surrounding tissues well down into the hand, the greatest care being used to avoid cutting any of the branches in the palm Where blood-vessels are met, especial care is taken to preserve them

"The tendons as far as possible are dissected out of the mass of connective tissue It is frequently necessary to use the connective tissue itself as tendons The tendons are dissected and flaps of fat are inserted, one layer under the tendons, one between the superficial and deep tendons, and one above The wounds are then closed" (Kanavel<sup>18</sup>)



muscles should regain two-thirds of their former contractile power such a degree of contraction would still be insufficient to draw the fingers into complete flexion, and in such cases it is necessary to shorten the flexor tendons as well as release them from scar tissue. In the same way, if the flexor muscles have remained contracted throughout the duration of an extensive infectious process *no amount of stretching which stops short of rupture of muscle fibres is adequate to overcome the flexion contracture even after the tendons have been freed throughout their entire extent, and in such cases the flexor tendons must be lengthened by a tendon lengthening operation or with the aid of a graft*

If tendon lengthening is carried out it is well to remember that the essential movement of the fingers from the standpoint of function is that of flexion. In the last analysis, aside from their normal antagonistic action to the flexor muscles, the extensor tendons serve only to open the hand. If complete restoration of both flexion and extension is impossible it is better to sacrifice a part of the function of extension. In other words, a patient who can extend his fingers incompletely, but sufficiently to put a glove on the hand without undue difficulty, and who can flex them forcefully into the palm has a much more useful hand than the patient who can straighten his fingers completely but cannot flex them into the palm or grasp small objects.

If, then, tenolysis can be satisfactorily accomplished and combined when indicated with shortening or lengthening of the tendons, if after the tendons are freed normal areolar tissue or fat is placed about them to help prevent reformation of adhesions, and if active movement is instituted promptly after operation definite improvement in function can reasonably be anticipated.

A brief account of a few specific cases may help to present the problem in a concrete form.

CASE I—J. H. Passavant Memorial Hospital (8818) December 16–19 1931. This patient, a boy of four years, had gradually developed a loss of function which consisted in an inability to extend the right thumb beyond an angle of  $135^{\circ}$  at the interphalangeal joint. If an effort was made to extend the thumb beyond this angle the base of the proximal phalanx was drawn volarward with a resulting volar subluxation at the metacarpophalangeal joint.

One month before admission to the hospital he had fallen to the floor while carrying a bottle in his right hand. The breaking glass caused two small penetrating wounds of the palm, and a third slightly larger wound just lateral to the mid-line of the volar surface of the thumb, a little proximal to the metacarpophalangeal joint. The wounds were covered with clean dressings and healed without infection. It was only after some weeks that the parents noted the disability described above.

December 16, 1931, under ethylene anaesthesia, the scar over the metacarpophalangeal joint of the thumb was excised and the deeper tissues exposed. The digital nerve to the radial side of the thumb was intact, the fascial covering of the flexor pollicis brevis was divided, but the muscle and tendon were intact. The tendon of the flexor pollicis longus was thickened opposite the joint, and firmly adherent to the base of the proximal phalanx of the thumb. Because of this adherence the thumb could not be completely extended at the interphalangeal joint, and when further extension was attempted the tension exerted upon the base of the proximal phalanx drew it volarward into a subluxated position. When the adherent tendon was freed from the bone the thumb could

## CONTRACTURES OF THE HAND

be extended completely and the tendency to volar subluxation had disappeared. On lifting the completely freed tendon into the wound a spindle-shaped enlargement could be seen at the point where the tendon had been adherent to the bone.

It seemed probable that the patient had sustained a partial division of the tendon at the time of injury, and that during the process of healing the tendon callus, represented by the spindle-shaped enlargement, had become adherent to the base of the proximal phalanx.

When it was evident that there was no other obstacle to the free movement of the tendon a thin layer of subcutaneous fat was laid underneath the tendon, the thin tendon sheath loosely closed with two fine silk sutures and the superficial wound closed. Healing took place by primary union, and when last seen, three weeks after operation, the patient was moving his thumb in a normal manner.

CASE II—O. F., Passavant Memorial Hospital (1910), February 20–May 24, 1930. This patient, a machinist thirty-two years of age, entered the hospital seven months after sustaining a severe crushing injury of the left hand with an extensive laceration of the palm, a compound fracture of the bones forming the middle metacarpophalangeal joint and a simple fracture of the proximal phalanx of the ring finger. The crushed middle finger was amputated immediately and the lacerated wounds sutured. A very considerable loss of function followed as a result of the injury and the extensive fibrosis which developed during the process of healing, but the feature of the disability of particular interest in connection with this discussion was the inability to extend the ring finger beyond a right angle at the proximal interphalangeal joint.

February 21 the flexor tendons of the ring finger were exposed through an incision on the radial side of the finger and tension put upon the distal phalanx. It was then seen that the flexor profundus had become firmly adherent to the bifurcating sublimis over the proximal phalanx close to the site of fracture. When the two flexor tendons were separated from one another by sharp dissection the finger could be extended with the exercise of very little force to  $170^{\circ}$ , or almost a straight line.

It seemed probable that the crushing injury of the hand, which was severe enough to produce with other injuries a fracture of the proximal phalanx of the ring finger, had possibly resulted in a partial division of the tendons at the site of injury and had certainly been followed by hæmorrhage into the tendon sheath as well as into the bone, and that as a result of the injury and associated hæmorrhage a fibrosis had developed at a site of constriction, namely the point of bifurcation of the flexor sublimis, with a resulting interference with the free gliding movement of the affected tendons.

During the two months during which this patient remained under observation there was no evidence of recurrence of the contracture of the affected finger.

CASE III—L. B., Passavant Memorial Hospital (11842), October 3–12, 1932. This patient, a boy of seventeen years, sustained two rather extensive wounds in an automobile accident July 25, 1932, the larger over the dorsolateral aspect of the left wrist, the second over the dorsal surface of the metacarpophalangeal joint. A half hour after the accident the wounds were cleansed and sutured; they healed without infection. Following the injury the patient was unable to extend the fingers of the left hand, the index finger was most seriously involved, the other fingers to a lesser extent. The appearance of the hand, and the degree of extension possible when he came to us in October, 1932, is shown in Fig. 4.

October 4 the oblique scar over the dorsum of the second metacarpophalangeal joint was excised and the adherent extensor tendons of the index finger freed from the overlying skin and underlying bones. There was no interruption in continuity. A thin flap of fat was laid underneath the freed tendons and the skin carefully sutured over them. A second, semilunar incision was made over the dorsum of the left wrist and the tendons exposed. The extensor pollicis longus was seen to lie uninjured in a normal sheath. The extensor digitorum communis was bound by scar tissue to the deep surface of the dorsal carpal ligament and to the floor of the dorsal carpal tunnel. After the tendons were

completely freed a thin pedunculated flap of subcutaneous fat was brought underneath them and held with a single suture. The dorsal carpal ligament was resutured rather loosely and the skin edges accurately apposed. A light splint was applied to relax the fingers by supporting the hand and forearm in dorsal flexion at the wrist.

The operative wounds healed by primary union and when the patient left the city



FIG 4—(Case III) Loss of function of extensor tendons due to scar tissue fixation following a cutting crushing injury (a), (b) Before operation (c), (d), (e) Result four weeks after tenolysis

four weeks after operation he had already regained a considerable degree of function (Fig 4 c, d, e)

CASE IV—W F, Wesley Memorial Hospital (115215), October 26–November 18, 1924. This patient, a blacksmith in a far western state at the age of twenty-four, fourteen years before admission to the hospital, accidentally drove a nail into his right palm. A veterinary surgeon immediately injected turpentine into the hand to prevent the development of infection. The hand, forearm, arm and shoulder became tremendously



FIG 5—(Case IV) Limitation of movement of fingers due to extensive fibrosis following injection of turpentine into the palm to prevent infection from a puncture wound (a), (b) Before operation (c), (d) Five and one half months after tenolysis of flexor tendons of middle finger. Note the increased range of movement of the three other fingers as well as the finger operated upon.

swollen, the skin of the palm sloughed away, and "large drainage holes were made" in the hand, forearm and arm. The function of the hand and fingers was lost for five months, but with persistent use and effort function gradually returned except for the fact that the middle finger remained flexed at the interphalangeal joints, and could not be extended beyond the position shown in Fig 5, a.

October 27, 1924, under local anæsthesia with  $\frac{1}{2}$  per cent novocaine the flexor tendons were carefully exposed through an extensive incision on the radial side of the

## CONTRACTURES OF THE HAND

finger From the middle of the middle phalanx as far proximalward as the distal flexion crease of the palm the flexor tendons were fixed by fibrous tissue After they were completely freed by sharp dissection the finger could be completely extended with the aid of a moderate degree of tension A pedunculated flap of subcutaneous fat was placed underneath the tendons and the wound closed without drainage

The operative wound healed by primary union Five months after operation the patient was able to flex and extend the index, ring and little fingers, the fingers not operated upon, almost completely, and definitely more fully than before operation\* (Fig 5, c, d) Extension and flexion of the middle finger was also practically complete

CASE V—J C, Passavant Memorial Hospital (6778), June 9-19, 1931 This patient, an editor forty-five years of age, fell on a broken glass bottle seven months before admission to the hospital, and sustained a severe laceration of the right palm He noted immediately that the index, middle and ring fingers were numb and that he was unable to move them at the interphalangeal joints He was operated upon shortly after the accident, the fingers were splinted in extension for three weeks after the operation, the operative wound was healed at the end of six weeks

On admission to the hospital the patient presented the symptoms of a complete division of both flexor tendons of index, middle and ring fingers and of the digital branches of the median nerve to these fingers The fingers were held in complete extension, but the joints were fairly flexible and the patient could flex the fingers almost into the palm with the help of the other hand On exposing the site of injury through a transverse palmar incision parallel with the flexion creases it was found that the tendons and nerves had been completely divided at the level of the middle flexion crease of the palm The distal segments of the tendons had retracted to the level of the metacarpophalangeal joints, the proximal segments to a line just above the wrist-joint After the distal segments were isolated and freed at the level of the metacarpophalangeal joints they were grasped with moist gauze in an attempt to draw them down into the operative field Since this could not be done an incision was made along the radial side of the index finger and the flexor tendons of this finger exposed within the digital sheath It was then found that the tendons were adherent to the sheath throughout its entire extent, and only when they had been freed by sharp dissection was it possible to draw the finger into flexion by tension upon the free ends of the tendons in the palmar incision To lessen the likelihood of reformation of adhesions the distal segment of the flexor sublimis was detached from its insertion at the base of the middle phalanx and removed, leaving the deep tendon alone within the digital sheath† The same procedure was carried out in the middle and ring fingers, and the remaining deep tendon of each finger then united by end-to-end suture to the proximal segments of both its superficial and deep tendons In other words, in each finger a single distal segment—the deep tendon—was united to the two proximal segments

Although this is a case of end-to-end suture of divided tendons and nerves, it is included in this group because of the tenolysis of the flexor tendons in the fingers and because it emphasizes the fact that if the flexor tendons have become "frozen" within the digital sheaths as a result of prolonged immobilization or a low-grade infection, or a combination of both, tendon suture or the bridging of the gap between the retracted ends of the divided tendons with grafts cannot be expected to bring about a helpful result If one cannot draw a finger into flexion by direct traction upon the ends of the flexor

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\* The improvement of extension in the fingers other than the one operated upon emphasizes the point which Bunnell has stressed, that fixation of the flexor tendons of one finger limits the movement of the remaining flexor tendons, and because of that fact it is unwise when one amputates a finger to suture the stumps of the flexor and extensor tendons to one another over the end of the exposed bone

† "To obtain more room in the finger the sublimis may be withdrawn and sacrificed, as the loss of its function is hardly noticed" (Bunnell\*)

tendons exposed in the palm, it is obvious that suture of these ends to the proximal portion of the tendons is a futile procedure

CASE VI—T Z Passavant Memorial Hospital (12219), November 14–December 11, 1932 This patient, a miner thirty-nine years of age, was first seen in November, 1932 He stated that August 5, 1925, he scratched the palmar surface of the right thumb with a piece of slag Three days later, August 8, because of swelling and pain, a small incision was made over the palmar surface of the proximal phalanx of the thumb and hot wet dressings applied August 13 another incision was made, the pain and swelling, however, became more marked and he was admitted to the hospital the same day Two days later the affected area was opened widely under general anaesthesia by an incision across the thenar eminence

He remained in the hospital with a draining wound for six weeks, the incisions finally healed in the latter part of October, 1925 While he was in the hospital the fingers gradually became fixed in a flexed position and the thumb flexed into the palm He returned to work in February, 1926, but little improvement was noted and the condition remained practically unchanged until November, 1932 In spite of the flexion contracture he worked steadily from 1927 to 1929, and intermittently from 1929 to 1932 During the

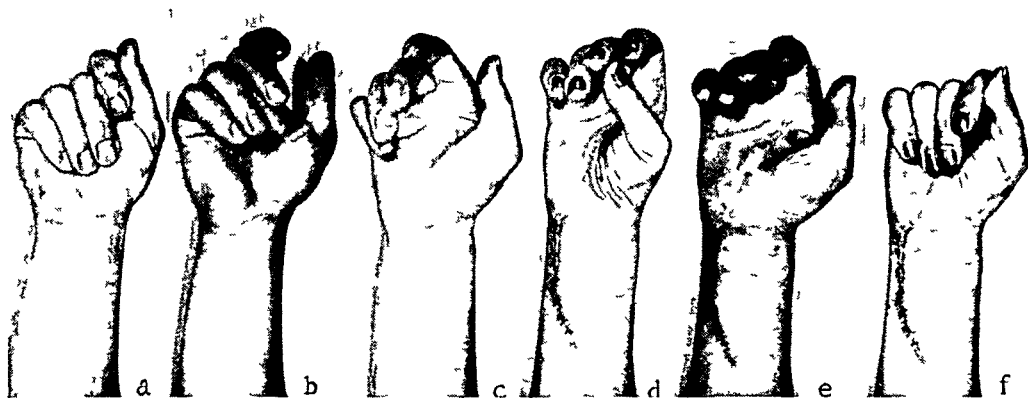


FIG 6—(Case VI) Flexion contracture of fingers and thumb due to spreading infection starting in tendon sheath of thumb (a) (b) (c) Before operation (d) (e) (f) Three and one half weeks after tenolysis of flexor tendons and insertion of graft to replace destroyed portion of flexor tendons of little finger

latter period the fingers, particularly the fifth, became a little more flexed, and there was some increase in pain, particularly over the original incision and between the fingers

The position of the fingers and condition of the hand is shown in Fig 6 The thumb and little finger could not be extended The index, middle and ring fingers could be extended almost completely when the fingers were completely flexed at the metacarpophalangeal joints

November 16, 1932, under ethylene anaesthesia, the flexor tendons were exposed in the hand and lower third of the forearm by the incisions indicated in Fig 7 From a level two inches above the wrist-joint as far distally as the middle flexion crease of the palm—in other words throughout the extent of the common flexor sheath—the flexor tendons were bound together in a mass of fibrous tissue When they were freed from the floor and walls of the carpal tunnel and from one another the thumb and medial three fingers could be extended fairly well The little finger, however, could not be extended even after the flexor tendons were freed in the finger as well as in the hand, for they had become contracted to such an extent that complete division was necessary to permit extension After they were divided and the finger straightened the resulting gap of one and one-half inches was filled with a free graft of palmaris longus A free graft of fat from the abdominal wall was laid between the flexor tendons and the floor of the carpal tunnel The wound was carefully closed, but no attempt was made to secure accurate reformation of the anterior annular ligament

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The operative wound healed by primary union. A week after operation a tension splint was applied to help draw the fingers into extension (Fig 7, a). Active physical therapy was begun thirteen days after operation, and continued until the patient left the city four weeks after operation.

In this case a diagnosis of Dupuytren's contraction had been made by the patient's physician, but the history is that of an infection of the tendon sheath of the thumb which subsequently extended into the forearm, involved the common flexor sheath, the ulnar bursa and the digital sheath of the little finger. It was noted above that when the fingers were flexed at the metacarpophalangeal joints the index, middle and ring fingers could be extended, in other words, these fingers were held in flexion by the fixation of their tendons underneath the anterior annular ligament and within the common flexor sheath, but not by adhesions within the digital sheaths. The thumb and little finger, on the other hand, were more markedly involved in the flexion contracture, and the fibrotic process involved the tendons throughout their entire course. It is interesting to note, in passing, how accurately this case exemplifies the course and extent of an infectious process which begins in the tendon sheath of the thumb and spreads along the channels which in the great majority of cases communicate directly with that sheath.

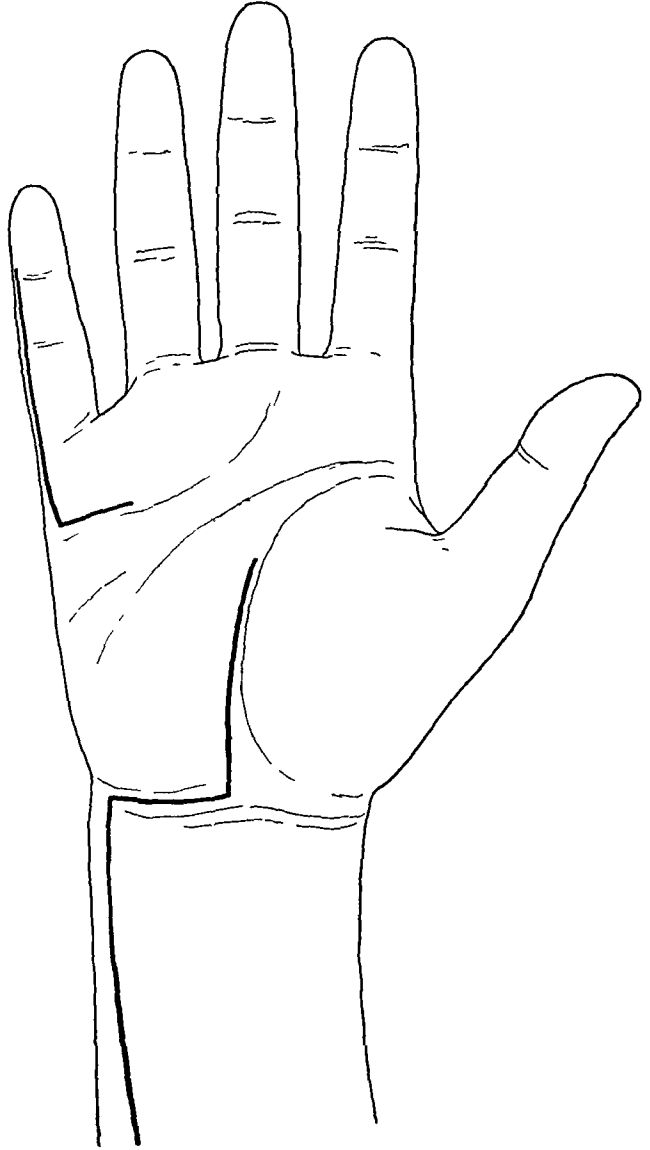


FIG 7—(Case VI) Incisions used to expose field of operation

CASE VII—W B, Wesley Memorial Hospital (108139), September 25–October 9, 1923, (108631), October 22–November 2, 1923. This patient, a salesman of twenty-nine years, sustained a deep, irregular glass cut of the volar surface of the left wrist in an automobile accident July 10, 1923. He was operated upon elsewhere shortly after the accident and the divided tendons sutured. Wound infection developed and delayed healing for some weeks. A complete loss of sensation of the palm was first noticed during the period of wound healing.

The appearance of the hand and the extent of movement present when the patient came to us two and one-half months after the accident is shown in Fig 8. At operation the sutured superficial flexor tendons and the divided median and ulnar nerves were found bound together in a mass of scar tissue. The proximal segment of the divided

ulnar nerve had become united to the distal segment of the divided tendon of the flexor carpi ulnaris. The divided ends of the median nerve were widely separated. The deep flexor tendons were involved in scar tissue but were intact. The tendons and nerves were carefully separated from one another, the superficial flexor tendons were shortened, the divided flexor carpi ulnaris and the divided ulnar nerve united by end-to-end suture. Because of the considerable gap between the divided ends of the median nerve the neuromata at the divided ends were temporarily united, so as to draw the separated nerve ends into apposition.



FIG 7—(a) Splint to bring elastic tension to bear on contracted fingers by means of loops and garter elastic tightened with the aid of small buckles

Four weeks later, October 23, the operative wound, which had healed by primary union, was reopened, the neuromata excised from the median nerve, and the freshened ends accurately united by end-to-end suture.

The functional result seven years later and the evidence of return of motor function of the median nerve, as indicated by the patient's ability to rotate the thumb so as to face the fingers, are shown in Fig 8, c, d.

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CASE VIII—L H, Wesley Memorial Hospital (86446), July 7-20, 1920, (88981), November 4-16, 1920 This patient, a nurse of thirty-one years, was admitted to the hospital in July, 1920, two years after a protracted and serious illness due to an acute and rapidly spreading streptococcic infection of the right hand and forearm which had

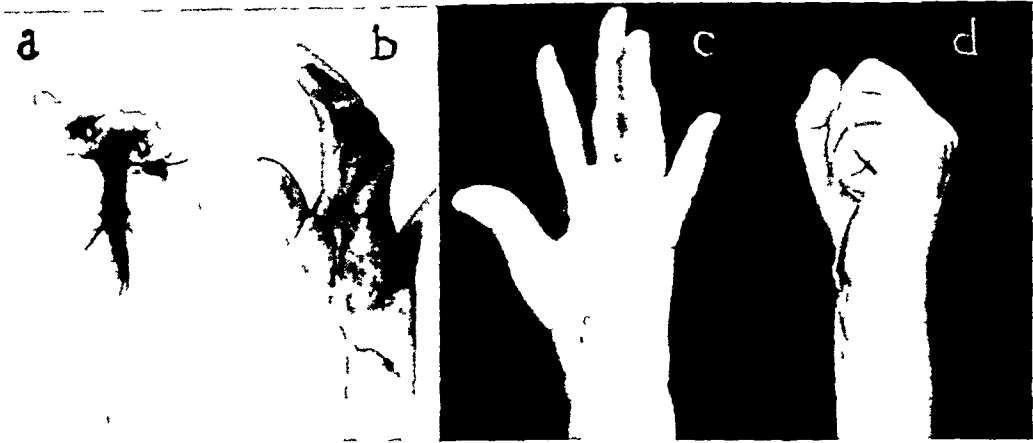


FIG 8—(Case VII) Loss of function of left hand resulting from lacerated wound injury of volar surface of the wrist with division of flexor tendons and median and ulnar nerves Tendon suture immediately after the injury and apparently without attempt at nerve suture was followed by wound infection (a), (b) Appearance of hand before secondary operation, two and one-half months after injury (c), (d) Result two and one-half years after secondary operation

tollowed a needle prick of the thumb It is unnecessary to recount the history she gave of her original illness and of the many and various operative procedures that were carried out during her five months' stay in the hospital When she came to us there was a complete bony ankylosis at the wrist-joint and a very marked limitation of movement of the fingers and thumb (Fig 9)

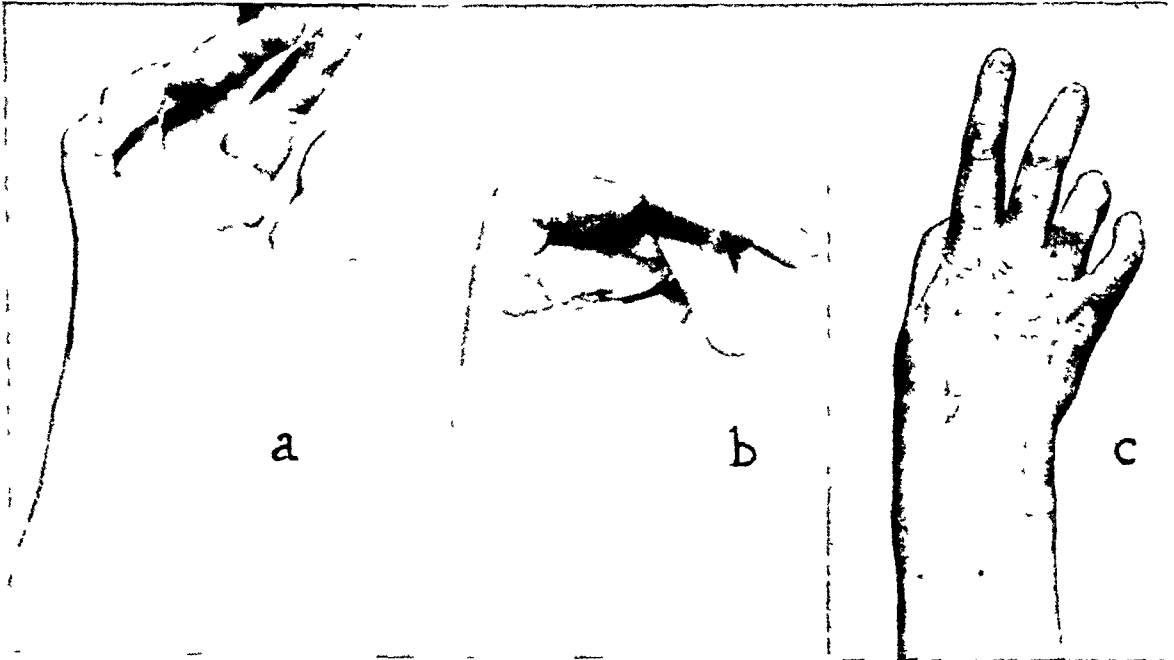


FIG 9—(Case VIII) Severe disability resulting from a streptococcic infection of the hand and forearm following a needle prick of the thumb (a), (b) Limits of extension and flexion before operation (c) Healed scars of multiple operative incisions made on dorsum of hand and forearm

July 8 1920 an arthroplasty was performed at the wrist-joint and the extensor tendons freed from overlying skin and underlying metacarpus and surrounded by thin transplants of fat Physical therapy was begun shortly after operation

November 5, four months after the first operation, the flexor tendons were freed



from the scar tissue which bound them together and fixed them to the surrounding tissues, shortened one-half inch and surrounded by thin fat transplants

Physical therapy was again instituted shortly after the second operation Fig 10

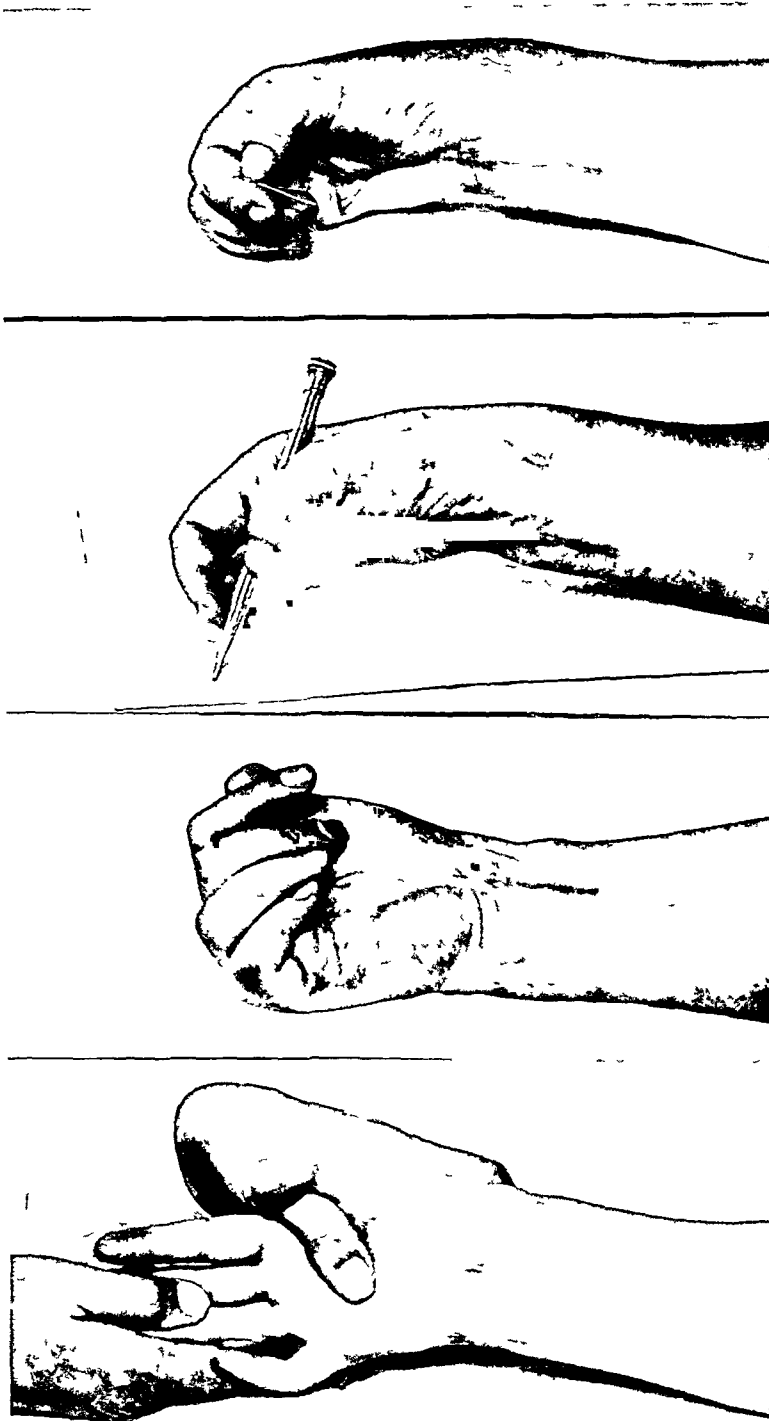


Fig 10—(Case VIII) Restoration of function four months after second operation in a hand which was practically useless as a result of extensive and long continued infection

indicates the improvement in function eight months after the first operation and four months after the second

It will be noted that these cases have been arranged in the order of their severity—the first and second with involvement of flexor tendons within a

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limited area, the third with localized involvement of extensor tendons, the fourth, fifth and sixth with more extensive involvement of flexor tendons, the seventh with extensive involvement of flexor tendons and division of the median and ulnar nerves, and the last with extensive involvement of both flexor and extensor tendons and with bony ankylosis at the wrist-joint

The operative procedures employed in each case without consideration of the associated nerve or joint complications, have consisted essentially in freeing the affected tendons from surrounding scar tissue and from one another by sharp dissection surrounding them whenever possible with fat from the adjacent tissues or from the abdominal wall,\* in some cases (for example, Cases VII and VIII) shortening flexor tendons which had remained fixed for a number of months in a position of complete relaxation, and in a few cases lengthening flexor tendons which had remained fixed in a position of complete contraction (see resume of cases, p 568)

In carrying out these operative procedures every attention possible has been paid to the details of surgical technic which have been stressed so often and by many men as of paramount importance† These are, particularly delay of any operative procedure until one can be reasonably certain that there are no longer virulent bacteria still living in the deeper tissues, careful preparation of the hand and forearm before operation, asepsis, the use of a bloodless field during operation incisions which avoid so far as possible cutting across flexion creases sharp dissection gentleness in handling tissues, careful hæmostasis the use of fine needles and fine suture material, accurate wound closure, the use of pressure dressings after operation and early post-operative mobilization

### TENDON GRAFTS

The use of grafts to replace a loss of tendon substance comes into consideration particularly in three groups of cases First, those in which a division of a tendon has remained untreated for so long a time that marked retraction of the proximal segment has taken place, and neither careful dissection nor stretching of the contracted muscle suffices to bring the proximal segment in approximation with the distal segment Second, those in which tendon suture has been carried out without success and in which because of post-operative oozing of blood and serum, post-operative infection, the use of heavy and irritating suture material, prolonged immobilization after operation or any one of several other causes, the sutured tendons have become so completely fused with the surrounding tissues that any attempt to free them,

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\* "In those cases in which the infection has been upon the dorsum of the hand alone incisions may be made to either side of the interwoven dorsal tendons, and a thin flap of fat inserted between the tendons and the bone and between the tendons and the skin This flap of fat should not be too thick, since it would then be difficult to close the skin wound If the technic is properly carried out such adhesions can be almost entirely eradicated and a practically complete function restored" (Kanavel<sup>16</sup>)

† "It is wise to draw attention to the necessity of the most scrupulous care in our technic, since such long and tedious dissection in tissue of low vitality is especially favorable to the development of infection" (Kanavel<sup>16</sup>)

with the expectation of maintaining freedom of movement afterward, is simply wasted effort Third, those in which, because of infection or injury, an extensive destruction of tendon tissue has taken place and resulted in a loss which can be compensated for only by replacing the destroyed tendons either with adjacent tendons which can be spared without loss of function or with tendons from the foot\* This last group includes neglected cases of tuberculous tenosynovitis in which conservative treatment has been continued until actual erosion and destruction of tendons themselves has taken place

In the use of such grafts a number of technical considerations are of importance The preparation of a suitable bed for the graft, the technic of uniting it with the tendon, the method of attaching it to the distal phalanx if the graft is to replace the tendons of a finger or thumb, the construction of a gliding mechanism about the graft, the formation of new annular ligaments to hold it in place, the tension at which it should be sutured and the degree of relaxation which should be maintained after operation are all of importance in securing a satisfactory result

*Preparation of a Bed for the Tendon Graft*—Various methods have been described for preparing a bed for the tendon graft within the finger, and we are considering the finger first because it offers the greatest difficulties Even after extensive infection within a finger with destruction of tendon tissue a part of the tendon usually remains firmly fused with the surrounding tissues The first step in preparing a bed for the graft is the removal of this fibrosed tendon To accomplish this Bunnell has used a modified cork borer with a sharp cutting edge to be applied with a rotary movement After the freed tendon is removed the graft is drawn through the newly formed tunnel with an elongated flexible carrier Auchincloss has used small narrow-bladed hæmostats, with the outer surface of the two blades sharpened like a knife, in order to form a tunnel into which the graft can be inserted Other surgeons have used various methods of blunt dissection to form a bed for the graft These methods have not proved successful in our hands, partly because of lack of technical ability, but to a certain extent we believe because they do not permit a sufficiently complete removal of the scar tissue which has replaced the normal tendon and tendon sheath, or in the event that the tendon has not been lost, which has surrounded the tendon and bound it to the tissues about it

It has always been a matter of surprise to us in dissecting in a finger from which the flexor tendons have sloughed as a result of infection, or in which an unsuccessful tendon suture had been done, how dense the scar tissue has become, how firmly any remains of tendon have fused with underlying bone and overlying fascia, and, in the event that the tendons have been lost, how little evidence of a tubular sheath is left behind If in such cases we have

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\* "Grafts are easily obtained from the sublimus tendon, the palmaris longus, the long extensors of the toes If the palmaris longus tendon plus its paratenon is used, it will be necessary to make a longitudinal incision the full length of the graft A long extensor tendon of the toes plus its paratenon in the dorsum of the foot can be taken without getting toe-drop as the extensor brevis digitorum will serve to extend the toes" (Bunnell '4)

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attempted to free the remains of a tendon with a cork borer by working distalward in a finger from an incision in the palm we have always been disturbed by the amount of force necessary to propel even such a sharp cutting instrument along the path of the tendon. At times we have supplemented this instrument by a small, narrow-bladed knife with a long narrow handle, and still have been confronted with serious mechanical difficulty in attempting to free the tendinous cord of scar tissue within its limited space, a space which is frequently curved in its long axis because of the semiflexed position of the finger. Simple mechanical difficulty is not a sufficient reason for giving up a sound surgical procedure, but we have abandoned this procedure because in

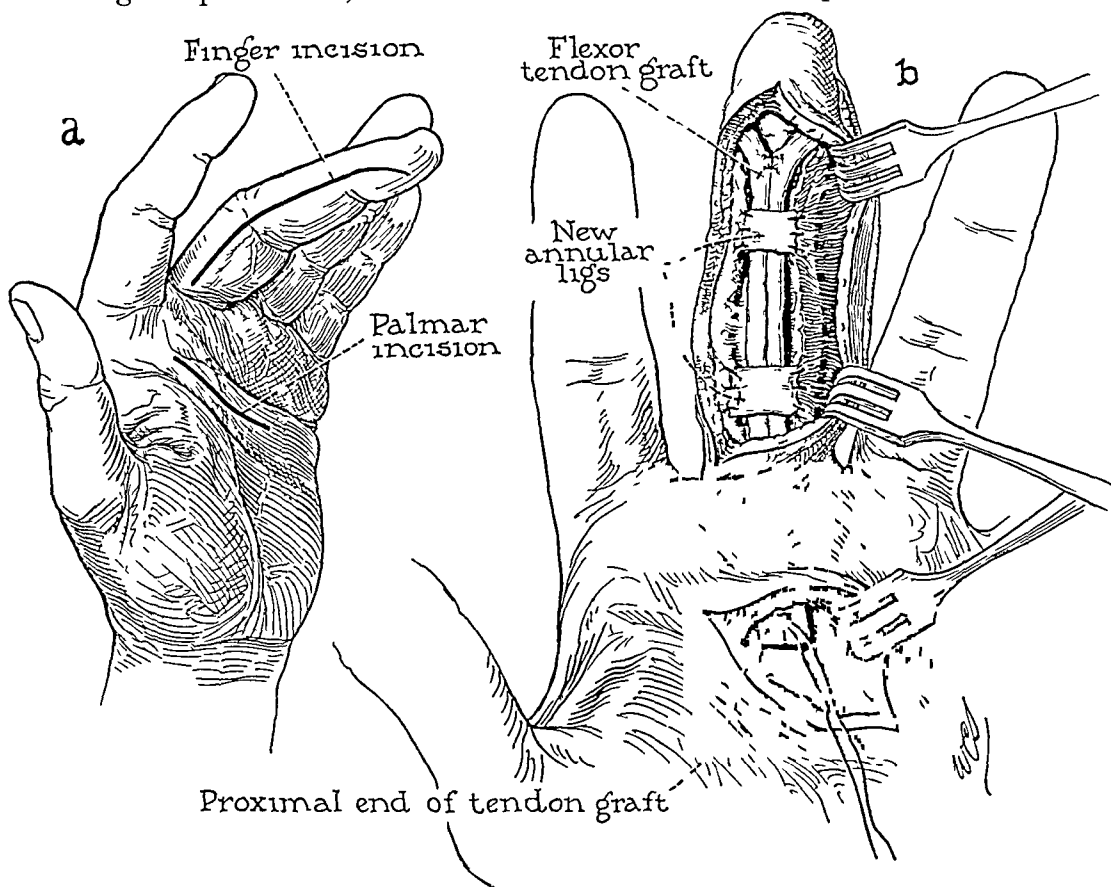


FIG. 11.—The technic of replacing destroyed flexor tendons of the middle finger with tendon grafts (a) The incisions of choice (b) Grafted tendons held in place by newly formed annular ligaments

our hands it necessitated undue trauma, with subsequent post-operative pain, induration and delay in healing, because it did not permit adequate removal of scar tissue and so jeopardized the functional result, and because we were always fearful of injuring digital nerves or blood-vessels which might have been displaced from their normal course by reason of scar tissue contraction or as a result of a previous operative procedure.

Instead, therefore, of preparing a bed for the tendon graft in the finger by one of the methods suggested above we have finally come to depend upon a careful excision of scarred tendon and remains of tendon sheath through an adequate incision made well to the side of the finger (Fig. 11, a) which avoids the flexion creases and so lessens the likelihood of formation of a contracting scar. Such an incision can be supplemented by a transverse extension from its distal end toward the opposite side of the finger, and should end

proximally close to the level of the web. The palmar dissection is carried out through an incision parallel with the flexion creases of the palm.

*Suture of the Graft to the Tendon*—A careful end-to-end union of the graft to the tendon is the method of choice. To be exact, we prefer to use the method (Fig 12, b-h) which has been particularly well described by Max Lange<sup>20</sup> and which has the important advantage, as shown by the experimental studies of Mason and Shearon,<sup>24</sup> of leaving practically free from any irritating effect of suture material that portion of the tendon where proliferation of tendon tissue must go on unimpeded if sound union is to take place. If both flexor sublimis and profundus are present and freely movable in the palm the sublimis may be cut off at a little higher level than the pro-

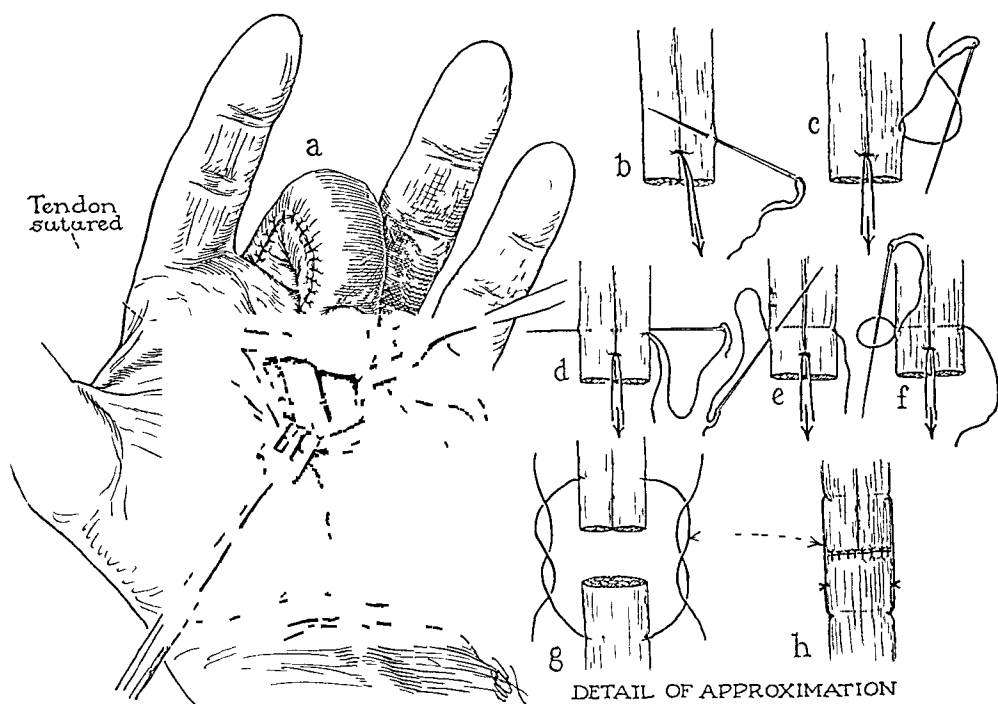


FIG 12—The technique of replacing flexor tendons of the middle finger with tendon grafts. (a) Suture of the finger incisions is completed after the grafted tendons have been laid in place. The proximal end of the grafts is sutured to the distal end of the intact tendon in the palm after the finger incisions are closed. (The degree of flexion of the affected finger is exaggerated in the illustration. The sum of the angles of flexion at the metacarpophalangeal and interphalangeal joints should be about  $90^\circ$ .) (b-h) Technique of end to end tendon suture. While the graft is being sutured to the tendon in the palm relaxation of both is accomplished by flexing the finger sharply to relax the graft and by flexing the hand at the wrist to relax the proximal segment.

fundus and the graft united end-to-end with the sublimis, and by a few lateral sutures to the slightly longer underlying profundus over which the proximal end of the graft is laid (Fig 17, a).

If the graft is to fill a defect between the end of a flexor tendon in the palm and its insertion on the distal phalanx of the finger it is important that before it is sutured to the graft the tendon in the palm should be carefully freed from the areolar and fibrous tissue which tends to immobilize it. The divided tendon in the palm is usually recognized by a slight yellowish discoloration at the cut end, seen through a transparent covering of areolar tissue. When this cut end is drawn down with some tension into the operative field the tendon and areolar tissue take on the appearance of an umbrella which

has been turned inside out by a gust of wind, the tendon being the handle and the areolar tissue the everted ribs and silk of the umbrella. Unless this areolar and fibrous tissue is cut away from the tendon by sharp dissection movement will be impeded and the result unsatisfactory.

*Method of Attaching the Graft to the Distal Phalanx*—Although it requires additional time to attach the graft to the distal phalanx and the procedure is somewhat difficult to carry out, experience has shown that it is wiser to excise the remains of a short stump of flexor tendon still attached to the distal phalanx and attach the graft itself directly to the distal phalanx than to suture the graft within the finger to a short fragment of remaining

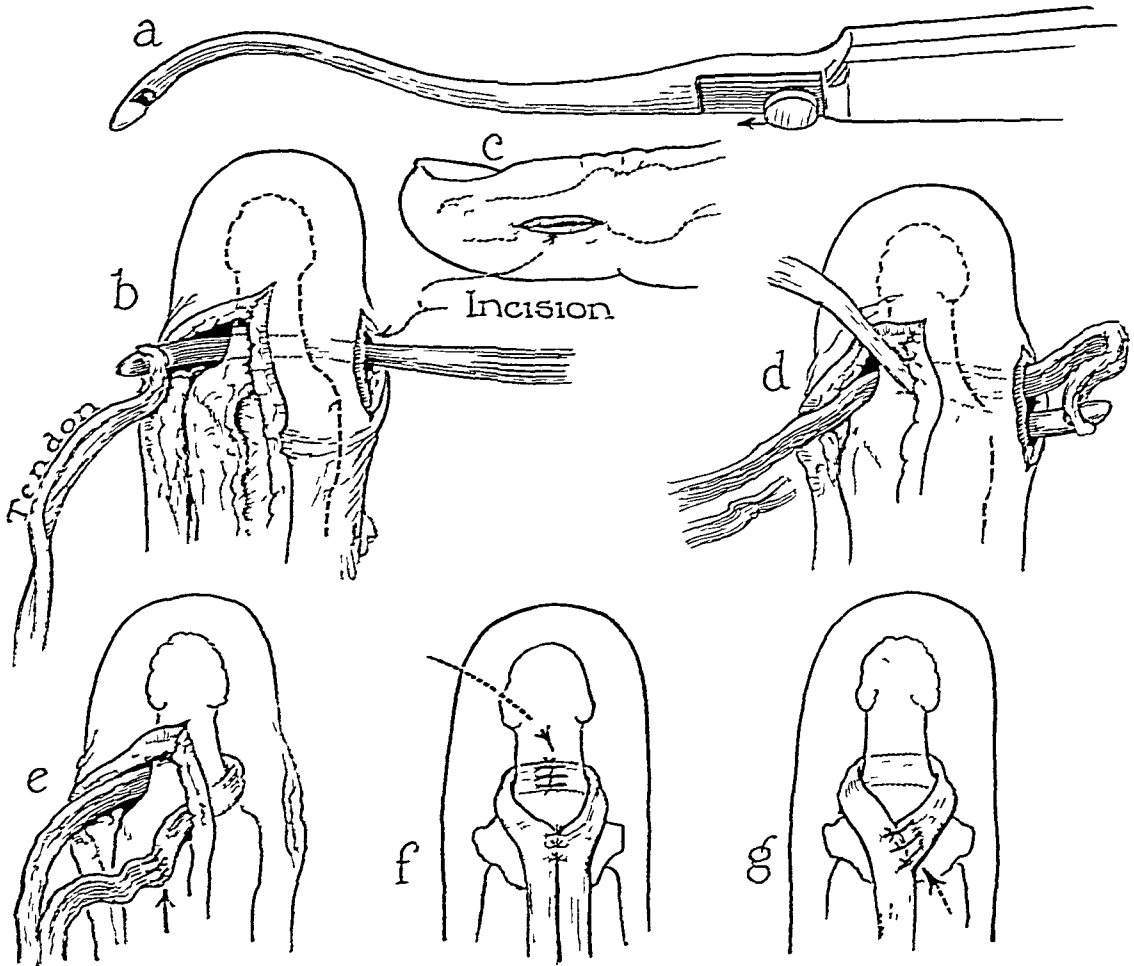


FIG. 13.—The technic of replacing flexor tendons of the middle finger with tendon grafts. Method of attaching tendon graft to the distal phalanx. (a) Reverdin needle modified to serve as tendon carrier. (b-f) Method of attaching tendon graft when two tendons are used. (g) Method of attaching graft when a single tendon is used.

flexor profundus. To attach the graft directly to the distal phalanx Bunnell has suggested boring a small hole through the bone, passing the end of the graft through the drill hole to the dorsum of the finger and suturing it to the periosteum and fibres of insertion of the extensor tendon. We have used this method successfully but if the graft is taken from the foot and two tendons can be spared for one finger we have found the method shown in Fig. 13 of advantage, for as a rule, the extensor tendons of the foot are slender and narrow, and two of them scarcely equal in mass a single flexor tendon to a finger. If a single tendon suffices the distal end of the graft can be passed

around the base of the distal phalanx and sutured to the graft on the volar surface by an end to side union (Fig 13, g)

*The Construction of a Gliding Mechanism about the Graft*—This problem offers one of the most difficult of the several involved in the use of tendon grafts. Various ingenious methods of surrounding a graft with a thin layer of fat and inserting the graft and its sheath within the finger have been described and pictured. As a matter of fact, they can be pictured more readily than they can be carried out. To draw a graft surrounded by a newly formed sheath of areolar tissue or fat through a subcutaneous tunnel, we have found very difficult. When we have tried it the sheath usually slipped away from the graft and was left curled up close to the point of insertion. The method of surrounding graft and sheath with a rubber tube before introducing it into the finger we have not attempted for we have rarely found it possible to construct a tunnel large enough to contain a graft, sheath and rubber tube combined. We have, therefore, contented ourselves with removing tendons from the foot with every care to leave attached to them the areolar or gliding tissue which normally surrounds them, and laying the tendons surrounded by this tissue in their bed. In procuring tendons from the foot we have sometimes found it of advantage just after dividing one end of the tendon in the foot to tie a catgut suture about tendon and areolar tissue so as to prevent drawing the tendon away from its covering tissue as it is dissected away from its site in the foot. The fact that we no longer attempt to form subcutaneous tunnels by blind dissection through relatively small openings in palm and finger makes the problem of retaining the gliding tissue about the tendon graft less difficult. In cases in which a part of the superficial flexor of the finger or of the palmaris longus is used for a graft we have sometimes laid a thin free graft of fat from the abdominal wall or from the subcutaneous gliding tissue over the triceps tendon\* underneath the graft to prevent it from becoming adherent to the underlying bone. There are two important facts, however, to remember in connection with the construction of a gliding mechanism about a graft: the first, emphasized particularly by Mason and Shearon in the report of their experimental studies on tendon repair, is that the tendon graft must develop a blood supply promptly if it is to survive, and the formation of this blood supply from the soft tissues surrounding the graft may be hindered or even made impossible if a thick layer of areolar tissue or fat is placed between the tendon graft and the surrounding connective tissue. The second is that there is present within the finger only a

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\* "If the paratenon is not removed intact with the tendon graft, paratenon fat may be gathered from elsewhere and planted sleeve-like about the tendon graft or other tendon to be mobilized. The fat over the triceps tendon is well suited for this purpose. Paratenon fat is specialized fat and differs much from the tough, short-fibred, subcutaneous fat. It is elastic and pliable and can easily be drawn a long distance back and forth from its moorings, as can be seen by comparing the mobility of the skin over the triceps tendon with that over the outer side of the arm." (Bunnell '4)

limited space for the insertion of graft and covering tissue, a space which is often smaller than that present in the normal finger because of the atrophy and destruction of tissue which have followed the original injury or infection. If one attempts to crowd too much tissue into this space, accurate approximation of the subcutaneous tissue and skin without bulging of soft tissue between the sutures becomes impossible, and since this accurate approximation of wound edges is an important safeguard against post-operative infection from without we feel that it must be secured.

Outside of the finger—in the palm and wrist, for example—we have come to believe that no especial effort to provide a separate sheath for a graft of normal tendon is necessary. We have been strengthened in this belief by the excellent results that have been obtained in cases of tuberculous tenosynovitis in which the parietal layer of the tendon sheath of the flexor tendons has been completely excised in forearm and palm and the tendons left bare in the carpal tunnel, with no tissue intervening between them and its walls. In such cases if the visceral layer of the tendon sheath has not been involved in the inflammatory process, but has been left bright and glistening, complete restoration of flexion and extension has taken place.

*The Formation of New Annular Ligaments*—The necessity of providing a substitute for the destroyed fibrous tendon sheath which holds the flexor tendon in contact with the finger and prevents it from standing out like a bow-string as the finger is drawn into flexion is as apparent as the necessity for having a tendon which can glide freely in its bed. Only in rare instances can the remains of the original fibrous flexor sheath be used for this purpose. Bunnell has constructed new annular ligaments by encircling the finger with a tendon graft which is passed between the bone and the extensor tendon on the dorsal surface of the finger, the free ends of the graft are united at one side of the finger, so that the line of suture of the newly formed annular ligament does not lie directly over the newly formed flexor tendon. Auchincloss has used both the slips of insertion of the flexor sublimis and fascial strips to form new annular ligaments.\*

We have used both of these methods, and have also laid free grafts of tendinous tissue transversely across the newly formed flexor tendon and attached them on each side to the remains of the fibrous flexor sheath with a few sutures of fine silk (Fig 11, b). In using the latter method we have sometimes taken a longer strip of tendon than was necessary and after suturing it in place as suggested, folded it upon itself at a slight angle and laid it back across the tendon at a slightly higher level. In this way a broader retaining ligament has been obtained. In any event, we have thought it wise when possible to provide an annular ligament opposite the middle phalanx.

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\*“One of the great difficulties is to provide phalangeal annular ligaments, where they have been destroyed, so as to prevent tendon prolapse. If the flexor sublimis tendon has its dividing slips along the side available it is possible to use these. If not, it may be necessary to transplant fascia” (Auchincloss<sup>2</sup>)



and opposite the middle of the proximal phalanx to hold the graft in apposition with the finger during the movements of flexion

In order to make as easy as possible the procedure of attaching the tendon graft to the distal phalanx, and of constructing new annular ligaments to hold it in its bed when tension is put upon it, we have come to perform these various steps of the operation in a definite order. After the remains of the scarred tendon have been completely excised, the graft is laid in place, and attached to the distal phalanx, preferably by the method illustrated in Fig. 13. A silk suture is attached to the free end of the graft, passed through the tunnel left by the excision of the scar tissue over the proximal portion of the proximal phalanx, and out through the palmar incision. With the graft laid smoothly in the finger and held there by slight tension on its free end the new

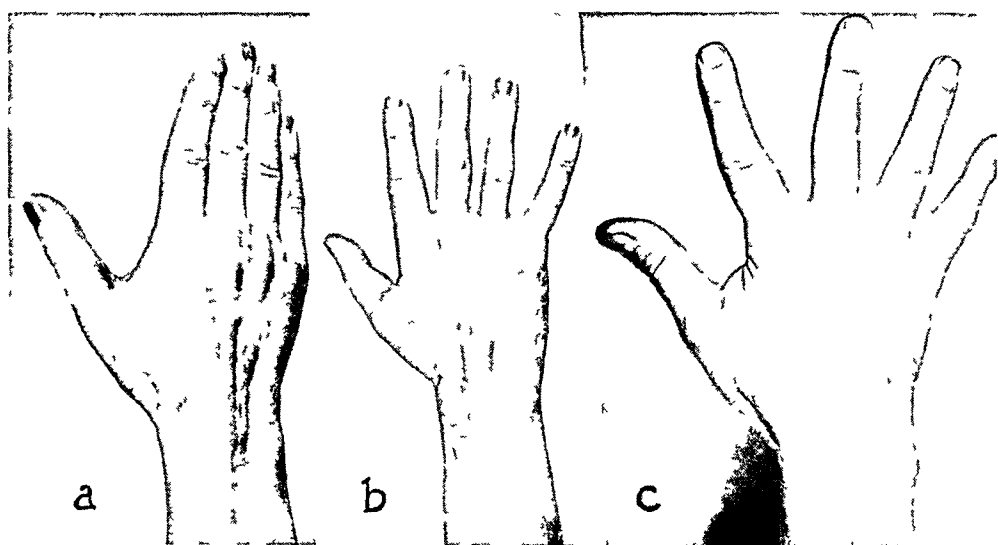


FIG. 14.—Use of tendon graft to replace a portion of the extensor pollicis longus destroyed as a result of a tuberculous tenosynovitis. (a) (b) Before excision of tuberculous tendon sheath and involved portion of tendon. (c) Result one year after operation.

annular ligaments are constructed as described above. When they are completed it is possible by putting tension on the proximal end of the graft to see exactly how well they function, and if they have been sutured under the proper degree of tension.

The next step is closure of the incisions in the finger with the aid of fine silk in the subcutaneous tissues and a fine skin suture. The finger incisions can be closed easily and accurately when the finger is extended, but only with difficulty if the suture of the graft to the tendon in the palm has been completed and the finger drawn down into semiflexion. After the finger incisions have been closed the proximal end of the graft is sutured to the distal end of the tendon in the palm. The graft itself is relaxed by flexing the finger. The tendon in the palm is relaxed by a suture inserted an inch proximal to its free end and used as a guy rope to draw the tendon into the palmar incision.

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while it is being carefully united to the graft. The final step is closure of the incision in the palm.

*The Optimum Degree of Tension for the Graft*—The optimum degree of tension at which the graft should be sutured to the tendon and which should be present during the first few weeks after operation while the graft is becoming united to the tendon has not yet been determined\*. During the operation and immediately after, excessive tension on a graft on the volar surface of the hand or forearm is avoided by moderate flexion at the metacarpophalangeal joints and more marked flexion at the wrist. This position is maintained after operation by the use of a light aluminum splint on the dorsum of the hand and forearm. In the same way excessive tension on grafts on the dorsal surface of the hand and forearm is eliminated by a volar splint which holds the fingers almost completely extended and the wrist in dorsal flexion. It is our belief that the relaxation obtained by splinting should be sufficient to avoid anything greater than slight tension upon the tendons at the line of suture when the hand is at rest, but that there should still be enough tension so that contraction of the affected muscles can produce a pull on the tendon grafts and movement of the affected fingers.

Early movement, not forceful or long-continued, but carried out at the time of daily dressing, seems to us an important factor in preventing formation of adhesions about tendon grafts and providing the normal physiological conditions for healing and growth.

### RESUME OF CASES OF TENOLYSIS AND TENDON GRAFTS

During a period of seventeen years, from May 1, 1916, to May 1, 1933, we have had the opportunity of treating 101 cases

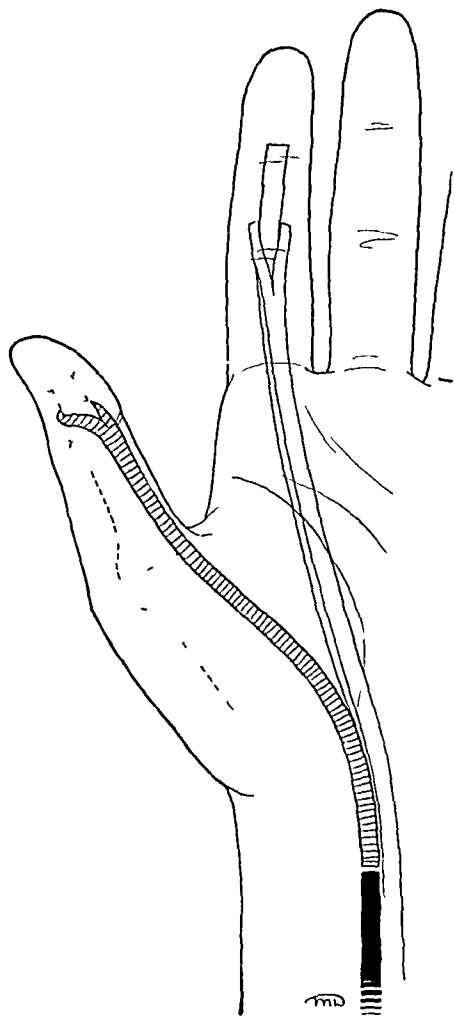


FIG. 15.—Use of tendon graft to replace flexor pollicis longus divided at the level of the metacarpophalangeal joint three months before. The proximal segment had retracted upward above the level of the wrist. (a) Diagram of operative procedure, the graft is indicated by the portion of the tendon with transverse lines.

\* "Muscle and tendon have a definite length, happily termed by Stoffel their physiological length. This length can vary within the range of the normal motion of the joints bridged by the muscle and tendon. If an abnormal position of the joints is assumed as, for instance, in the case of the dog, flexion of the knee and extension of the foot, tendon and muscle are unable to accommodate themselves to this unusual demand.

"The practical application of these laws is simple. To restore the normal tension the operator need only approximate origin and insertion of the muscle and tendon in question and suture the tendon to its new position without any tension whatsoever. For

of complicated contracture of the hand by tenolysis, or the use of tendon grafts, or a combination of the two methods Through the courtesy of Drs Allen B Kanavel and Michael L Mason I have been permitted to include in this resume fifty-eight cases from the joint service of Doctors Kanavel, Mason and myself at Wesley Memorial Hospital and one case operated upon by Doctor Mason at St Luke's Hospital, in addition to forty cases from the service of Doctor Mason and myself at Passavant Memorial Hospital and two cases from my service at the Cook County Hospital

In thirty-nine of these 101 cases tenolysis alone was carried out, in ten, tenolysis with tendon shortening, in three, tenolysis with simple tendon lengthening Of the fifty-two cases in which tenolysis was carried out, all

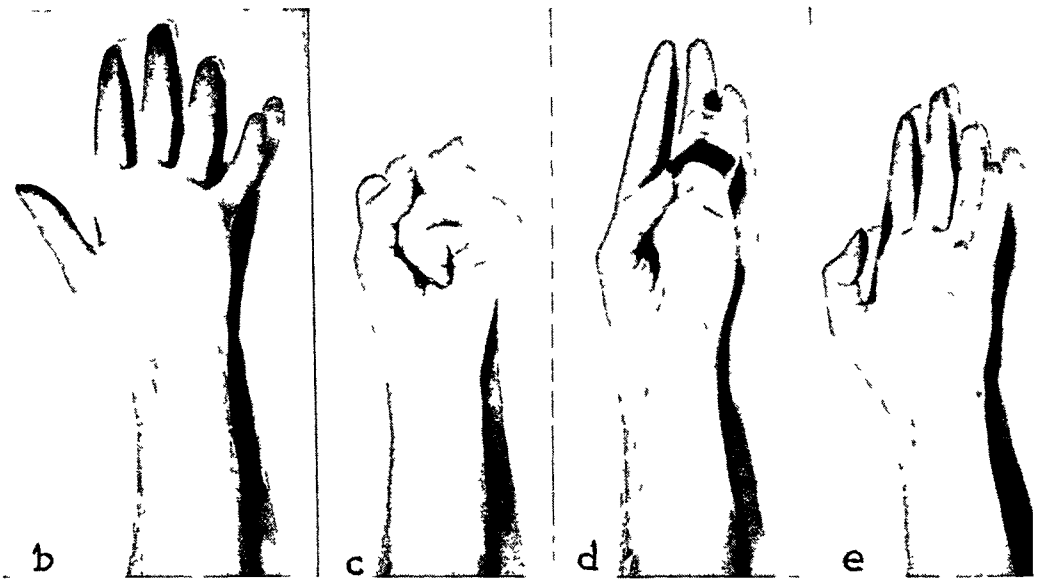


FIG 15 —(b), (c), (d), (e) Result six months after operation

of the flexor tendons of fingers and thumb were involved in nineteen cases In three of the nineteen cases an extensive involvement of extensor tendons was present as well, and tenolysis of these tendons was carried out at a second operation In thirty-nine of the 101 cases grafts were used and the tenolysis was confined to the tendons in which the loss of substance necessitated the use of a graft, in ten cases an extensive operation to free fibrosed tendons or remove inflammatory tissue was combined with the use of tendon grafts

instance, in transplanting the peroneal tendon for the paralyzed tibialis anticus, the foot should be held in the position of calcaneovarus and the peroneal tendon sutured to its new point of insertion with just sufficient tension to render it taut" (Mayer<sup>25</sup>)

There are, however, at least two additional factors which must be taken into consideration the degree of fibrosis which has taken place in the muscle itself, with its resulting loss of both relaxation and contractility, and the extent of separation which takes place at the lines of suture, a factor which Mason and Shearon have found to be constantly present no matter at what degree of tension the tendons are sutured, nor what method of end-to-end union has been used

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The last group included two cases of extensive tuberculous tenosynovitis which had gone on to tendon destruction \*

Of the forty-nine cases in which grafts were used one digit alone was involved in thirty-seven cases (Figs 14 to 17), two digits in six cases, three digits in one case, four digits, the extensor tendons of the four lateral fingers, in one case, and five digits, the flexor tendons of all the fingers, in four cases (Fig 18) Of the thirty-seven cases in which a single digit was involved grafts were used to replace the flexor tendon of the thumb in six cases, the flexor tendons of the index in ten cases, the flexor tendons of the middle finger in six cases, the flexor tendons of the ring finger in two cases, the flexor

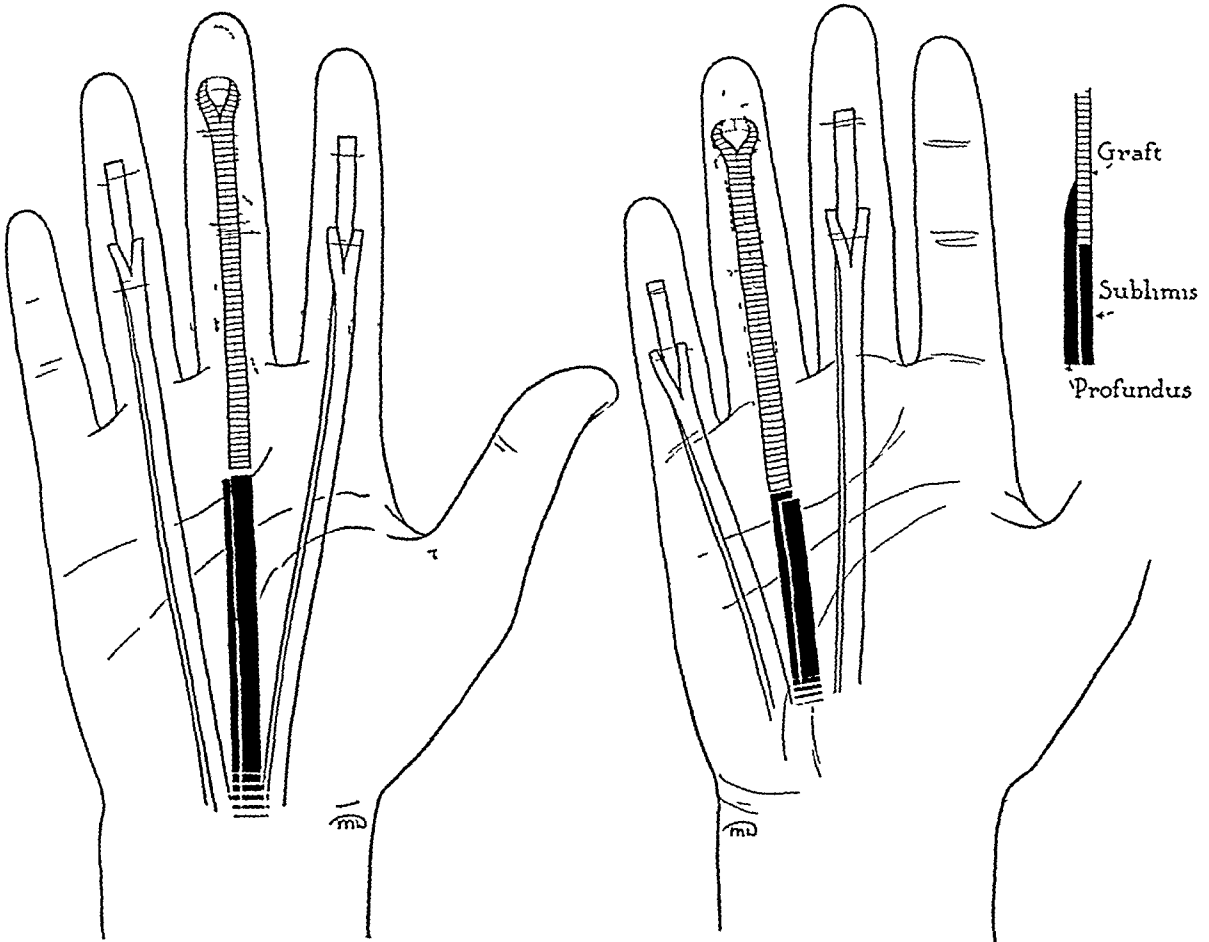


FIG 16—Use of tendon graft to replace flexor tendons destroyed as a result of a suppurative tenosynovitis (a) Diagram of operative procedure, the graft is indicated by the portion of the tendon with transverse lines

FIG 17—Use of graft to replace flexor tendons of ring finger following division eleven months before and two unsuccessful attempts at tendon suture (a) Diagram of operative procedure, the graft is indicated by the portion of the tendon with transverse lines

tendons of the little finger in eight cases, the extensor tendons of the thumb in two cases, the extensor tendons of the index in two cases and the extensor tendon of the ring finger in one case

In eighteen of the 101 cases the operation was preceded by and in five cases combined with the application of a pedunculated flap In twenty-three cases a division of the collateral ligaments of the metacarpophalangeal or interphalangeal joints or an arthroplasty at one or more metacarpophalangeal or

\* Only the cases of tuberculous tenosynovitis in which the destruction of tendons necessitated the use of tendon grafts are included in this series

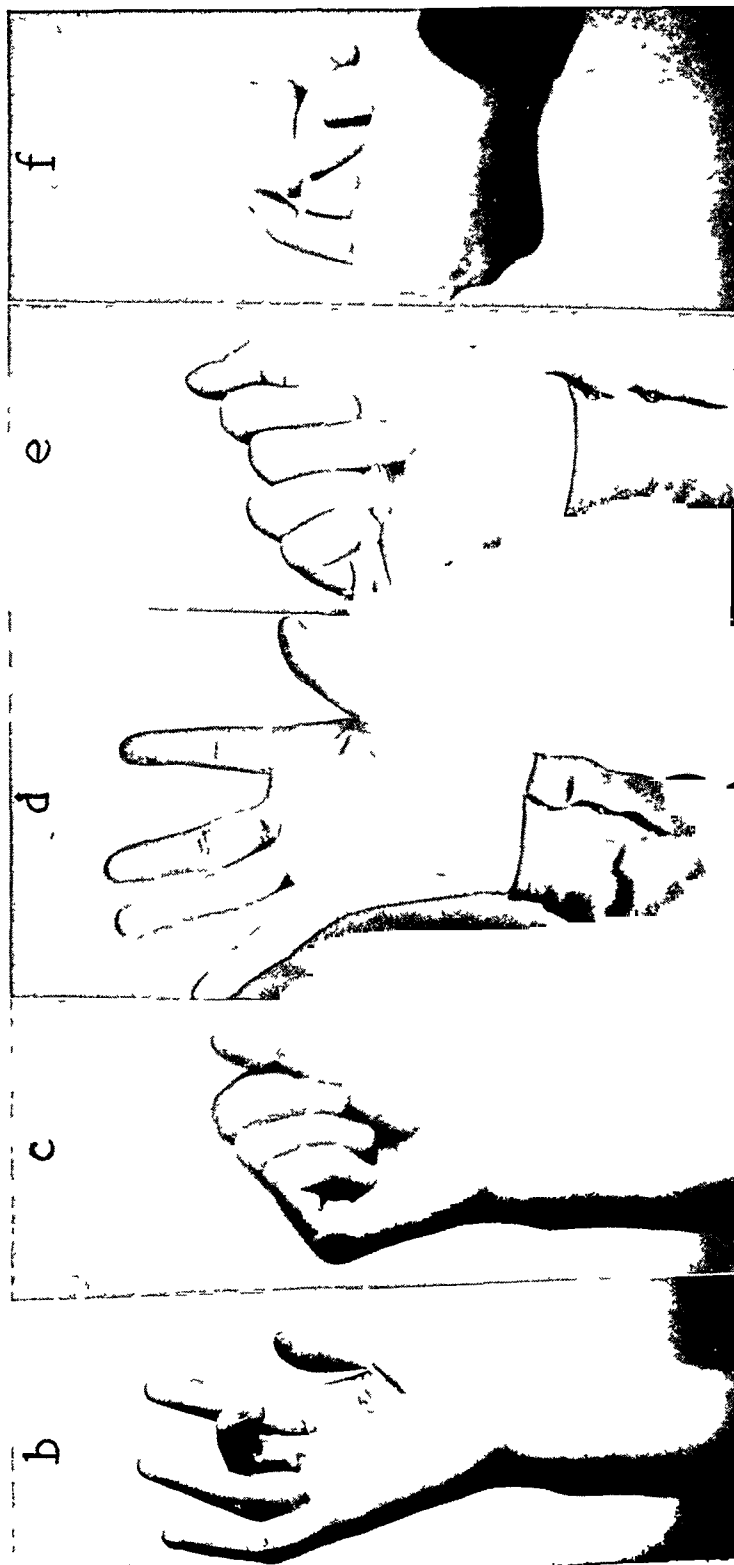


FIG 16—(b), (c) Appearance of hand before operation. (d) (e), (f) Result nine months after operation with restoration of ability to flex the finger at the distal interphalangeal joint. This result would not have been possible if a median longitudinal incision had been made to drain the tendon sheath at the time of the acute infectious process.

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interphalangeal joints was carried out before or at the same time as the tendon operation. In four cases an arthroplasty at the wrist-joint preceded the

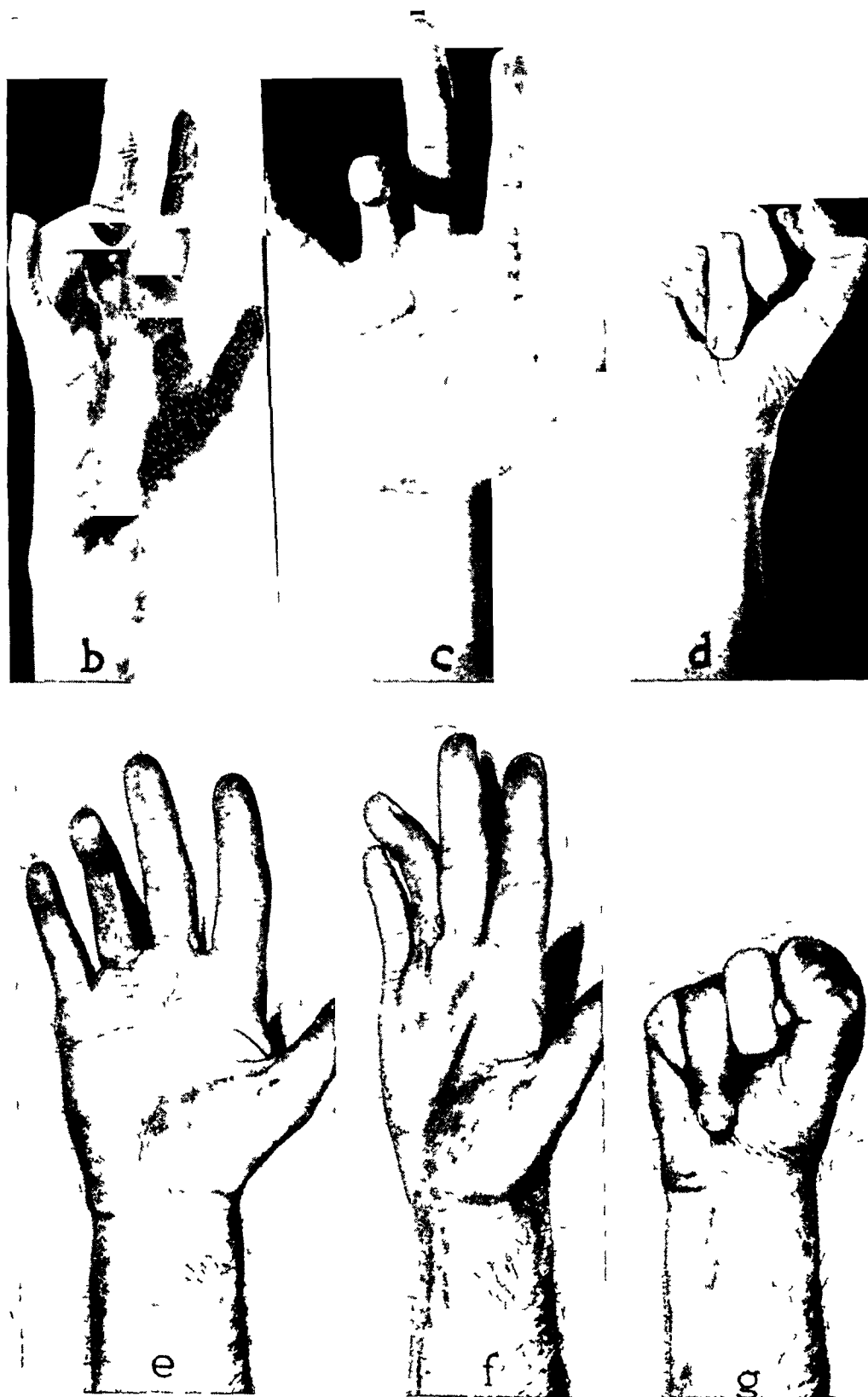


FIG. 17—(b), (c), (d) Appearance of hand before operation (e), (f), (g) Result five months after operation

tendon operation. In nine cases suture of the median or ulnar nerve, in four cases suture of both median and ulnar nerves, and in eight cases suture

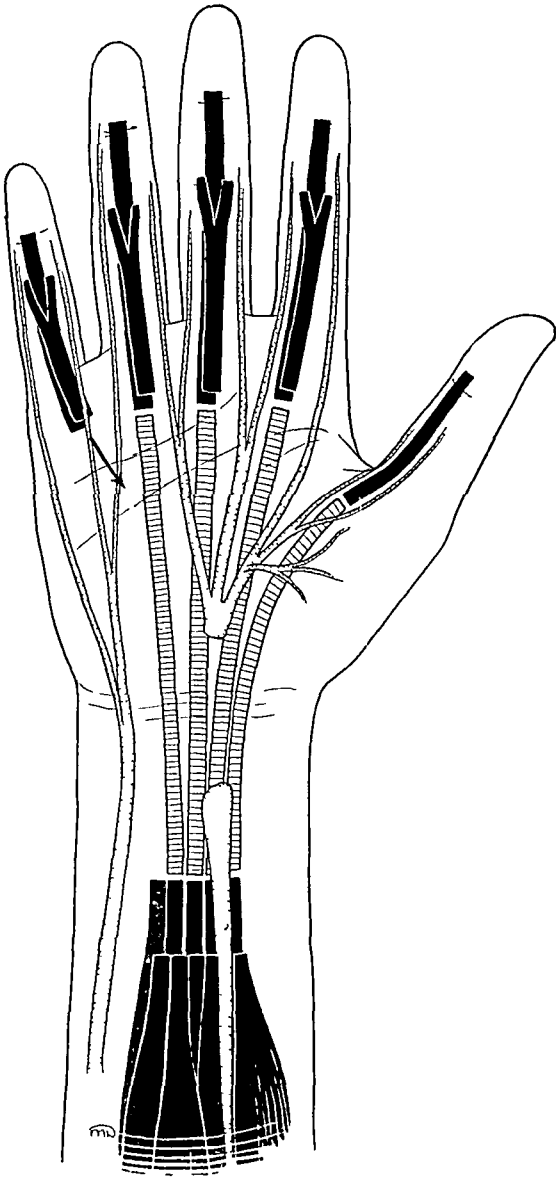


FIG 18—Use of tendon grafts to replace flexor tendons destroyed as a result of a long continued streptococcal infection of the hand and forearm and protracted drainage with a rubber tube inserted through a palmar incision and emerging in the forearm. Diagram of operative procedure, the grafts are indicated by the portions of the tendons with transverse lines. In this case tendon grafting was preceded by arthroplasty at the wrist joint and suture of the divided and eroded median nerve.

of one or more digital nerves was performed simultaneously with the tendon operation. In twelve cases more than one of the above procedures—for example, the application of a pedunculated flap and suture of the divided median nerve—were carried out in addition to the tendon operation. These procedures are mentioned simply to emphasize the fact that these cases are truly complicated cases and that several operations have frequently been necessary to secure a satisfactory result\*.

The original causes of the disability in the 101 cases cited were fairly well divided between infection and injury. In thirty-seven cases, and these included the majority of cases of practically complete disability, the contracture was due to an acute and rapidly spreading infection which followed a comparatively trivial injury, in fifty-four cases the contracture followed an extensive injury, in seven cases it followed a severe burn. In two cases tendon destruction was due to a tuberculous tenosynovitis, in one to a fibrosarcoma.

Seventy-seven of the patients were males, twenty-four females. Their ages varied from two years to seventy-two years, although only two patients were past the age of forty-seven. The youngest patient was a girl of two years, the oldest

\* "The amount of work one can accomplish in a hand in one operation is limited by the time it is safe to maintain ischemia. Dissection of the hand is so dangerous and difficult when the blood is flowing that all of that part of the work including nerve suture, repair of pulleys, tendon sheaths, and tendons is best completed before the tourniquet is released. As the time necessary to accomplish this in cases where several tendon grafts and nerve sutures are to be done is surprisingly long, it is compulsory to work rapidly. Even then several operations may be necessary to repair a badly damaged hand" (Bunnell<sup>5</sup>).

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a man of seventy-two Five patients were in the first decade of life, fifteen in the second, thirty-four in the third, twenty-seven in the fourth, eighteen in the fifth, one in the sixth and one in the eighth

The duration of hospital stay varied from one to ninety-three days, the average period was 18.4 days, an average duration of hospital stay increased considerably by the twenty-three cases in whom the application of a pedunculated flap formed a necessary part of the treatment The average period during which physical therapy was carried out in fifty-one recent cases was 96 days the average number of treatments forty-five In the remaining cases we do not have an exact record of the period during which physical therapy was given

*Results*—If results of surgical procedures are difficult to evaluate they are particularly so in the types of cases under discussion Perfect results and restitution to a normal condition after serious injuries or infections involving the hand are ideals impossible of attainment On the other hand surgical procedures which bring about a restoration of usefulness in one or more stiff fingers and eliminate the necessity of their amputation and which, in more serious cases lead to a restoration of function sufficient to enable the patient to return to his former occupation are worthy of serious consideration

The results obtained in some of the cases under discussion are illustrated above (Figs 4-6, 8-10, 14-19) Still better results were obtained in some of the remaining cases not illustrated, in others less satisfactory results were obtained

In eleven of the 101 cases no improvement resulted and a brief report of these cases may help to indicate some of the possible causes of failure and methods of preventing them in the future

CASE XI\*—E. A. C., Wesley Memorial Hospital (118899), May 21-25, 1925 This patient a physician of thirty-one years, developed a tendon-sheath infection of the left middle finger shortly after sustaining a needle puncture wound of the finger-tip Upon admission to our service two and one-half years later the finger was fixed in flexion

At operation under local anæsthesia the tendons were freed from their intrathecal adhesions and an anterior capsulotomy performed at the proximal interphalangeal joint A free transplant of fat from the thigh was wrapped about the freed tendons Following operation a part of the skin flap and underlying tendons became necrotic and sloughed The raw surface was subsequently covered elsewhere with a pedunculated graft from the adjacent ring finger At the same time the proximal segment of the remaining tendon was sutured to the base of the middle phalanx

March 14, 1928 he wrote 'I am able to flex the finger fully at the metacarpophalangeal joint and the proximal interphalangeal joint Extension at the metacarpophalangeal joint is also complete I am able to extend the phalanges only slightly beyond a right angle

Figure 20 indicates the final result in this case a very creditable result for which we can claim no credit as our operation because of the infection which followed it resulted in failure

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\* This group of cases is numbered XI to XXI in order to avoid confusion with the group of cases whose histories were detailed above



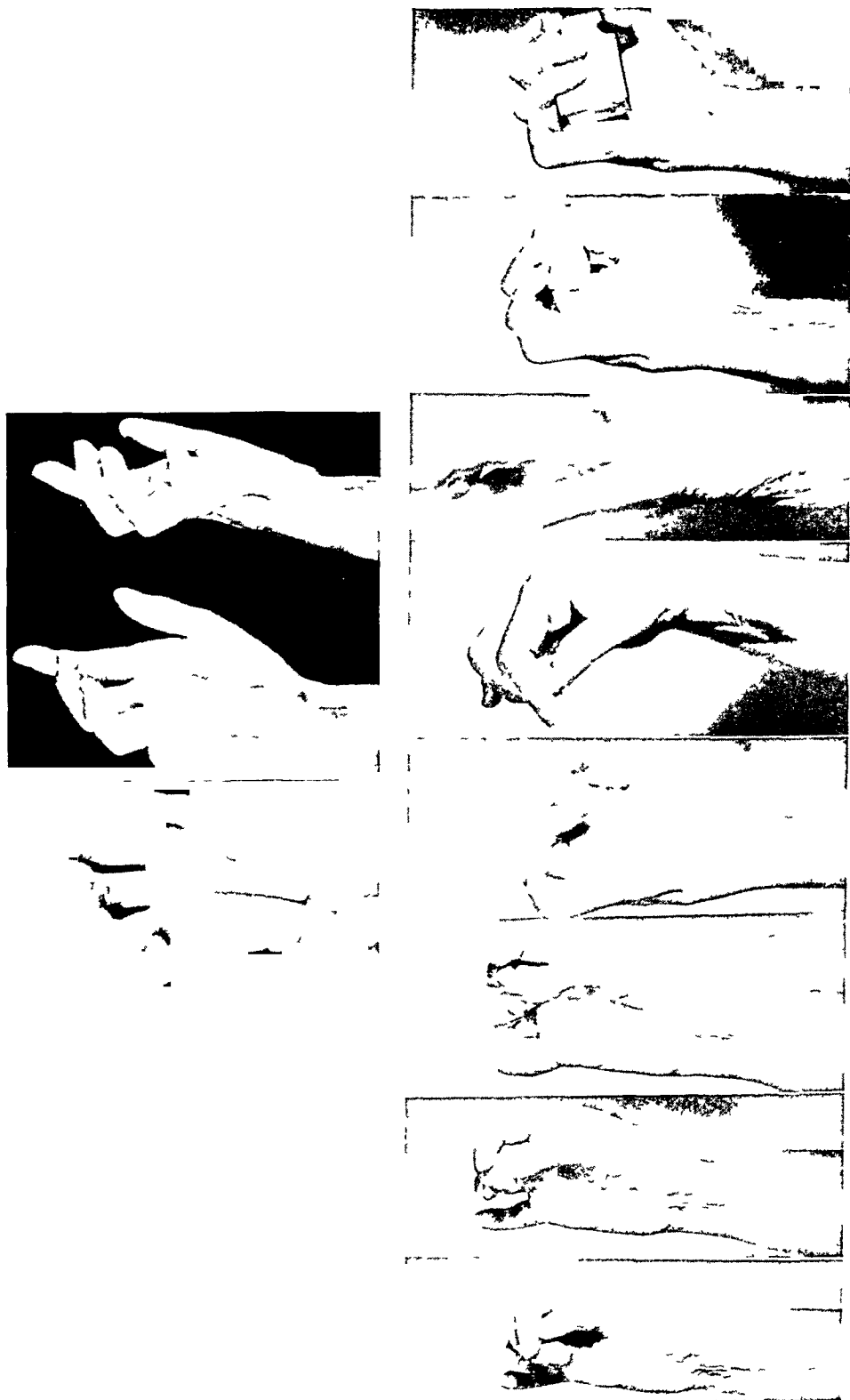


FIG 19—Same case as illustrated in FIG 18 Upper Row—Appearance of hand before operation The fingers and thumb were motionless Lower Row —Result one year after incision of tendon grafts

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CASE XII—A F H, Wesley Memorial Hospital (96141), December 5-17, 1921  
This patient, a physician of thirty-eight years, developed an acute streptococcic infection of the right index finger five days after scratching the volar surface of the middle phalanx while performing a tonsillectomy. The infection spread to the tendon sheath and to the thenar space, later a localized abscess formed over the dorsal surface of the lower end of the forearm, and the flexor tendons of the index finger eventually sloughed.

Twenty months after the onset of the infection the median longitudinal scar on the volar surface of the finger, representing the incision through which the infection had been drained, was excised, the fibrous cord-like remains of the flexor tendon sheath isolated and shortened, and surrounded with a free transplant of fat from the abdominal wall. An arthroplasty was performed at the distal interphalangeal joint. Healing took place without infection, and he left our care shortly afterward.



FIG. 20.—(Case XI) Final result obtained in a patient in whom the flexor tendons of the middle finger had been destroyed by infection, and in whom tenolysis and the use of a fat transplant had again been followed by infection.

Ten years later, September 16, 1931, he wrote "The best I could get out of my right index finger was passive flexion, and as it stuck out straight due to the fact that the extensors were strong and the flexors did not work, I had the finger amputated at the junction of the proximal and middle phalanx.

"I am sorry that I could not get the full use of my right index finger, but the right middle finger compensates very well, and as my surgical work on the eye makes it necessary for me to be ambidextrous, I get along very well, and do not notice the absence of the two distal phalanges of my right hand."

This patient was one of two (Cases II and VI) in whom amputation of the affected finger was finally performed to prevent it from interfering with the usefulness of the hand.

CASES XIII and XIV—G B, Wesley Memorial Hospital (137034), March 4-17, 1928, L D, Wesley Memorial Hospital (141947), December 6, 1928-January 11, 1929. In both of these patients, the first a man of thirty-seven, the second a woman of forty-

three, the flexor tendons of the right index finger were partially destroyed, in the first case as the result of a spreading infection, in the second as the result of an unsuccessful tendon suture following tendon division from a porcelain faucet injury. In both cases the lost flexor tendons were replaced by a graft, and the graft attached to the distal phalanx by passing it through a drill hole in its base. In both cases this attachment failed to hold and no restoration of the ability to flex the finger was accomplished.

CASE XV—H S, Wesley Memorial Hospital (130085), February 22–March 1, 1927. This patient sustained a division of the flexor tendons of the right little finger as the result of a glass cut in December, 1925. An unsuccessful tendon suture was carried out a month later, the finger remained fixed in flexion.

Upon admission to our service thirteen months later the fibrosed tendons were excised and replaced by a tendon graft from the foot. Wound infection developed after operation, the tendon graft was lost and no helpful result was accomplished.

CASES XVI and XVII—D B, Passavant Memorial Hospital (4017), September 25–December 11, 1930, H S, Passavant Memorial Hospital (5755), March 13–May 19, 1931. In both of these patients, young men of twenty-two and twenty-six years, respectively, the flexor tendons of the right middle finger were destroyed as a result of a slight injury which went on to a suppurative tenosynovitis and destruction of the tendons. In both cases a pedunculated flap from the abdominal wall was used to replace the scarred contracted skin over the volar surface of the finger and a tendon graft laid underneath the skin flap. In the first case no improvement resulted, and amputation of the finger was subsequently performed to remove a finger which could not be flexed and so became a handicap in the use of the hand. In the other case a slight restoration of flexion was accomplished, but not sufficient to justify the time and effort expended. In both cases the fibrosis which had developed about the interphalangeal joints, in addition to the fibrosis which developed about the graft itself, proved an insuperable obstacle to restoration of the power of flexion.

CASE XVIII—E H S, Wesley Memorial Hospital (82796), December 4–9, 1919. This patient, a physician of forty-three years, developed an acute spreading infection of the right index finger following the appearance of a small pustule on the medial aspect of the distal interphalangeal joint. He stated that six incisions were made to secure drainage and that the infection persisted for about ten weeks. It finally resulted in an ankylosis at both interphalangeal joints.

December 5, 1919, the fibrosed remains of the flexor tendons were freed and an arthroplasty performed at both interphalangeal joints. Free fat transplants from the thigh were interposed between the bone surfaces.

December 17, 1930, he stated "I regret to say that both joints are ankylosed in the straight position."

CASE XIX—A H, Wesley Memorial Hospital (144549), May 19–June 22, 1929. This patient, an automobile mechanic of thirty-five years, received a compound injury of the right hand from flying steel December 29, 1927. The thumb was amputated at the interphalangeal joint, the fingers were cut in a number of places. The proximal phalanges of the middle and ring fingers and the metacarpal of the little finger were fractured. The fractures were reduced immediately and again a few days after the injury. The middle and ring fingers were dressed in acute flexion for nine days.

On admission to our service fifteen and one-half months after the injury his chief disability consisted in an inability to flex the middle and ring fingers into the palm (Fig 21, a). The following day an incision was made on the radial side of each of the affected fingers and the tendons freed from the adhesions which bound them to one another and to the flexor sheaths. After they were freed by putting tension upon the flexor tendons exposed in the palm it was possible to flex the affected fingers completely into the palm. Free fat transplants from the abdominal wall were laid underneath the the digital portions of the freed tendons.

Complete healing was delayed until eighteen days after operation because of a low-

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grade infection which developed in the operative wounds. At that time physical therapy was begun and continued for sixteen days. The patient returned to his former work July 5, 1929.

February 17, 1930, the patient stated he did not think the operation had resulted in any improvement (Fig 21, d, e), but he was able to use his hand effectively at his former occupation.

CASE XX—B M, Passavant Memorial Hospital (3106), June 22–July 25, 1930, (4384), November 3–6, 1930. This patient, a woman of twenty-five years, developed a firm flexion contracture of the right little finger following a division of the flexor tendons in an automobile accident, and three subsequent unsuccessful attempts at repair.

Upon admission to our service a tubed flap of skin and subcutaneous tissue was applied to the finger to replace the firm contracting scar on its volar surface. Subsequently a tendon graft was inserted underneath the flap to replace the excised remains of fibrosed tendons.

As in Cases VI and VII little improvement resulted because of our inability to counteract both the fibrous tissue formation, which tended to fix the interphalangeal joints in flexion, and the reformation of fibrous tissue about the graft.

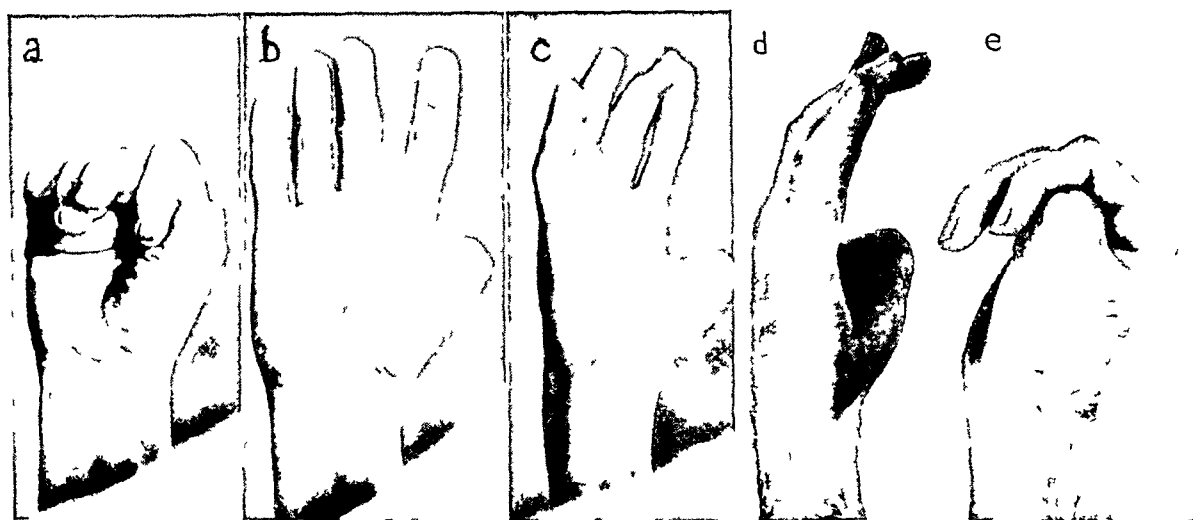


FIG 21—(Case XIX) Limitation of flexion of middle and ring fingers following compound fractures of the proximal phalanges and fixation in a flexed position (a), (b), (c) Condition before operation (d), (e) Failure of improvement after tenolysis of the digital portion of the flexor tendons because of low grade wound infection.

CASE XXI—H W, Wesley Memorial Hospital (124528), April 14–May 17, 1926, (128610), November 25–December 1, 1926, (135906), December 27, 1927–January 21, 1928. This patient, a boy of fifteen years, sustained a severe injury of the right hand in November, 1925, from an accidental discharge of a shotgun at a distance of three feet from his hand. The skin and tendons were torn from the proximal half of the palm, and a number of the carpal bones were fractured. He remained in the hospital for a month after the injury.

On admission to our service April 14, 1926, the fingers of the right hand were immobile, held in slight flexion. A deep healed irregular scar extended obliquely across the palm, approximately at the level of the base of the thumb. There was complete anesthesia in the area of median-nerve distribution.

April 16 the scar tissue was dissected from the palm, the thumb abducted from the hand, and the hand laid under a double pedicled flap raised from the right lumbar region. The flap was separated from its attachments May 10 and the raw edges sutured to the hand.

November 25 the patient returned to the hospital, and on the following day through an incision along the ulnar border of the flap the palm was explored. The median nerve

and flexor tendons were freed as completely as possible from a dense mass of scar tissue. The divided flexor tendons of the ring finger were sutured. Because of the extensive gap between the divided ends of the tendons of the little finger the distal segments of these tendons were united by lateral suture to the tendons of the ring finger. Even when the dissection was completed it was not possible to draw the fingers easily and completely into flexion by traction upon the flexor tendons in the palm. The operative wound healed by primary union.

December 27 the patient re-entered the hospital and tendons from the left foot were transplanted into the palm to substitute for the scarred and fibrosed flexor tendons of the little and ring fingers.

April 26, 1933, his physician in California wrote "At the present time he is suffering from rather marked flexion contractures of the middle, ring and little fingers and is partially incapacitated from following his proposed career of athletic coach and physical education director. I feel, however, that a further plastic operation plus adequate physical therapy will restore this hand to somewhat normal function."

These cases help to emphasize several facts, first of all the very obvious one that post-operative infection is almost certain to cause failure, and nothing in the way of post-operative care or physical therapy can counteract its unhappy results. Second, that to free the fibrosed remains of flexor tendons and tendon sheath from the soft tissues to which they have become adherent as the result of a suppurative tenosynovitis or an injury which has been unsuccessfully operated upon, and expect the freed scar tissue to act as a gliding tendon and draw the finger into flexion is an almost hopeless procedure. Third, that it is necessary to secure a firm and permanent attachment of a tendon graft to the distal phalanx if the graft is to draw the finger into flexion. Fourth, that mobility of the interphalangeal joints is essential to free movement of the fingers, and unless it is possible by an operative procedure or physical therapy or both to overcome the scar tissue formation which invariably takes place about the small joints after an infection or injury freeing of fibrosed tendons or their replacement by tendon grafts cannot be expected to bring about restoration of movement.

In considering the possibilities of restoration of function in cases such as these, and the results obtained, two factors in addition to those mentioned seem to us of great importance. The patient's will to secure a useful hand and the time factor. It is hardly necessary to point out that if a patient is determined to do everything in his power to secure the maximum degree of usefulness he will accomplish much more than the patient whose mind is intent on the extent of his disability and the financial compensation he can obtain. The patient whose history is detailed under Case IV, for example, both because he used his hand constantly at his work as a blacksmith, and so received the best kind of physical therapy, and because he was determined to regain the complete use of his hand, eventually secured an excellent functional result. The patient whose history is detailed under Case VI, on the other hand, has just recently refused to return to his physician for examination, apparently for fear of having his compensation for partial disability diminished or discontinued.

## CONTRACTURES OF THE HAND

The time factor is also of great importance.\* Muscles which have remained long inactive and undergone a considerable degree of atrophy can contract normally only when their tendons are first freed from contracting scar tissue, or are again united to their normal insertion. With restoration of movement made possible and with gradual regeneration of muscle fibres taking place day by day under the stimulus of active movement a constantly increasing degree of muscle power develops. As a result patients who leave one's observation after a few weeks or months of post-operative physical therapy often return after several years with a considerably greater improvement of function than one had anticipated, and this increasing improvement with time and use has been one of the most important factors in stimulating us to bend our efforts toward improving our technic and toward carrying out every detail of treatment that offers assurance of helping to bring about the desired result.

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\* "If the patient is willing to undergo two or three operations, and to carry out treatment for a number of months after operation the results will surpass one's expectations. Improvement in these cases does not cease at the end of six months or a year, but will continue for four or five years, the patient should be inducted into work in which he can use his hand, and should be advised and urged to use it." (Kanavel.)

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## TRANSTHORACIC ABDOMINAL HERNIA

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PENETRATING wounds above or below the costal arch may involve either the thoracic or abdominal cavity separately or both simultaneously. In the latter event those in which the point of entrance lies above the costal margin may pass through the diaphragm into the abdomen, and conversely, those which first enter the abdomen may pass obliquely through that muscle into the thorax. Such wounds are necessarily often complicated by the penetration of vascular and vital organs which lie in close proximity to the diaphragm and in that event, patients frequently die quickly from hæmorrhage or, more tardily, from the penetration of an unclosed orifice of some hollow viscus. There is always a mathematical possibility that penetration may occur without opening either pleural cavity or the pericardium and that such a wound may even extend onward through the diaphragm and its lining peritoneum without damage to either a thoracic or an abdominal viscus. Such a possibility is permitted by the fact that in passing from the diaphragm to the thoracic wall, the pleura leaves the most dependent lateral angle of the thoracic cavity and the adjacent attached diaphragm on either side uncovered—the so-called “costo-mediastinalis” sinus—of which, owing to the variation in the dimensions and symmetry of this interesting anatomical space, further detailed description is unnecessary. It is precisely through this extrapleural space and above its inferior or diaphragmatic surface that a penetrating wound may enter both chest and abdomen without material damage.

It is a well-known fact that herniæ frequently develop through scars in the abdominal wall. Through similar scars in the diaphragm, as well as through congenital defects in that muscle, hernia of one or more of the abdominal contents may take place. In that event the hernial sac and its contents, even when of large size, are confined within the thoracic cavity. The thoracic wall seems to be proof to the pressure that such a hernia may exert and the writer has found no instance of a diaphragmatic hernia “pointing” through an intact intercostal space. Protrusion of a portion of the lung through a penetrating wound of the chest has been observed. This strictly is a “prolapse”—not a hernia—although frequently either term is used interchangeably. When such a prolapse is reduced—and that usually is readily accomplished—and the wound is closed, no subsequent hernia ever develops. Even after resection of one or more ribs, so commonly done for the drainage of empyema, with the exception of Lehman’s case, no hernia has ever been observed. In that case, reported in the *ANNALS OF SURGERY* for May, 1927, hernia followed five years after the opening of a subdiaphragmatic abscess,



in which extensive portions of the eighth and ninth ribs were sacrificed. Through the ensuing scar to the weakness of which both the partial loss of the ribs and the associated necrosis of the diaphragm contributed, a sliding hernia containing the spleen developed. In the writer's cases, herewith reported, according to the patient's account, the bayonet wound quickly healed without thoracic or abdominal complications and consequently without any loss of substance in either the thoracic wall or diaphragm.



FIG 1—Transthoracic abdominal hernia

A D., aged forty-eight years, admitted to the Knickerbocker Hospital in 1930. During the World War the patient, previously robust and healthy, received a bayonet wound in the left side. So far as can be ascertained, this caused neither thoracic nor abdominal complication and healed promptly.

One day prior to the patient's admission to the hospital, on lifting a heavy trunk, the man experienced a sudden and sharp pain in the lower left chest in the scar resulting from the above wound and for the first time he noticed a swelling in the scar which increased perceptibly in size during the following twenty-four hours. There was also pain on inspiration.

Examination revealed a swelling in the lower left chest, several inches posterior to the axillary line (Fig 1). It was unaffected by position or by coughing. There

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was no impulse whatever. It was doughy in consistency. It was insensitive, and firm pressure failed to reduce its size. It was flat on percussion. In general, it presented the usual features of an irreducible epiplocele. Physical examination of both chest and abdomen was negative. There was no change in vocal fremitus or of the respiratory murmur over either lung. X-ray examination showed that the diaphragm was normal in the excursion of its movement and that it was symmetrical without change in its contour. There was only a slight shadow corresponding to the position of the swelling. The bony outline of the chest wall and both lungs were normal.

On operation the swelling, separated from its adjacent tissue, disclosed a well-defined pedicle emerging through an opening in the tenth intercostal space. The sac consisted of well-defined connective tissue without the glistening appearance common to either the pleura or peritoneum. On opening the sac a mass of omentum, the size of an orange, appeared firmly adherent to the neck and adjacent surface of the sac. Traction on the omental mass, as it was separated from the interior of the sac, caused some respiratory embarrassment. The mass was amputated after separation of the adhesions and ligation with catgut and gently returned through the opening in the diaphragm into the abdomen. The opening was closed by the suture of reflected periosteum from the surface of the tenth rib, over which the intercostal muscle and the fascia were sutured separately with chromic gut. The pleural cavity was not opened and the partially adherent stump of the omentum to the peritoneum prevented any frank exposure of either the peritoneal cavity or its contents. Unfortunately, recent attempts to locate the patient have proved unsuccessful.

What particular operation is best adapted for the relief of this condition is debatable. Preliminary exposure of the hernial sac and its contents through an overlying incision is of course, essential. Adequate reduction may possibly require a separate abdominal incision. The hernial canal can then be satisfactorily closed from below, assisted by pressure of the affected part of the diaphragm from above, or, vice versa, aided by upward pressure of the diaphragm, the hernial orifice can readily be sutured through the original thoracic incision. That such an ideal procedure was not applied in the present instance was due to a disinclination to incur the risk of a ventral hernia through an abdominal scar. Moreover, the danger of opening the pleural cavity and especially of the resulting pneumothorax seemed to justify the attempt to close the hernial orifice through a comparatively small intercostal incision in the manner described. In the event of a recurrence a more complete exposure of the hernial orifice and its subsequent closure either from below or above, or both could be attempted in the manner described as in the usual diaphragmatic hernia.

It is of interest to note that bayonet wounds from which the patients survive in any war are rare. Not one was observed by any member of the staff of Evacuation Eleven during the Argonne Campaign nor was any mention made of such a wound in the hospitals of Tours and Orleans to which the writer was attached as consultant after the Armistice. Even in the Civil War in which the lines were in much closer contact and where it is said that opposing soldiers in the "bloody angle" at Spottsylvania endeavored to bayonet their adversaries by thrusts between the logs by which the earthworks were reinforced the late Doctor Weir, a former President of this Association and in charge of a large hospital at Frederick, Md. from the battle

of Antietam on, informed the writer that he never saw a bayonet wound during his entire term of service

The discrepancy between the history and the actual lesion as disclosed by operation is also worthy of comment. In place of an acute condition of twenty-four hours' duration as indicated by the history, the hernia, although probably of considerably smaller size, must have existed for years. Such a discrepancy is not uncommon in inguinal and femoral herniæ, in which the patient's attention is directed to the swelling by sudden onset of pain, and when, shortly afterward, on operation, the omentum is found not only firmly adherent to the sac but so completely plugging its narrow communication with the peritoneal cavity as to have prevented any trace of impulse on prior physical examination.

The writer is greatly indebted to Doctor Lehman for calling attention to the case which he had previously published in the *ANNALS OF SURGERY*, mention of which he had failed to notice in the *Index Medicus*. It is also of interest to note that the term of "transthoracic abdominal hernia" was selected by both Doctor Lehman and himself, independently, to describe what in fact is a surgical curiosity.

DISCUSSION—DR EDWIN P. LEHMAN (University of Virginia) remarked that Doctor Eliot had mentioned a case that he reported several years ago. It is unquestionably a rare condition and it had seemed to him worthwhile to present it for that reason. The similarities and the differences between his case and Doctor Eliot's are interesting. The case was reported in the *ANNALS OF SURGERY*, 1927, p. 797.

This patient gave a history of having had a subphrenic abscess some five years before which had been treated elsewhere. He had noticed bulging in the left lower thorax for three years which had been associated with pain for only about three weeks. The important features of the case were a bulging in the left lower thorax in which a sharp edge could be felt, X-ray showed at times a loop of colon in the protrusion and at times a solid body which later proved to be the spleen. Intratracheal insufflation with lipiodol showed the absence of lung in the hernia. At operation a sliding hernia was found involving the attachment of the spleen and the colon. The diaphragm was attached to the seventh rib. There was a defect involving the eighth and ninth ribs for a distance of about six inches. Closure was obtained by using the spleen as a tampon and suturing it to the edges of the defect. The closure was reinforced with fascial sutures employed by Doctor Galley's technic. At the end of seven months the defect was entirely firm. A recent report, nearly seven years after operation, is that the patient is entirely well.

DR FRANK K. BOLAND (Atlanta, Georgia) said that during the past ten years he had had under observation 750 cases of penetrating wounds of the chest. Three-fourths of these were made by stab wounds, a great many by ice picks, and one-fourth by gunshot wounds. In all of these cases they had had no instance such as Doctor Eliot had described, no hernia of this kind. He, however, could speak of especially the lack of infection in these penetrating wounds of the chest. In their series only twelve cases of empyema developed, with one death, and only one pulmonary abscess.

In the text-books one is led to believe that infection is very apt to follow penetrating wounds of the chest, but it has not proved so in their experience. In many of these cases, other wounds that were made at the same time became infected but the pleural wound did not. He thought the pleura must be endowed with greater power to resist infection than had been thought in the past.

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DR JOHN F CONNORS (New York City) said that about two years ago it was decided at the Harlem Hospital that their mortality was too high from hæmorrhage in stab wounds of the chest. It was decided then that these cases should be operated on and the internal mammary and intercostal arteries ligated. During the last year they had had forty penetrating wounds of the chest with no mortality. In these cases they had found two diaphragmatic herniæ. One of these was unrecognized. The cases died from a pyopneumothorax due to the gangrenous area of the stomach which had penetrated the diaphragm and ruptured. The other case was recognized as the omentum protruded through the diaphragm. This was ligated, replaced into the abdomen and the opening in the diaphragm was closed. It is very obvious that the diaphragm can be much more readily repaired from above than from below. It is very astounding to open one of these chest cavities with a collapsed lung and find the mediastinum misplaced, with the respiratory efforts interfered with. When the lung is once pulled to the chest wall, the breathing becomes regular, due to the stabilization of the diaphragm. In some of the cases they had found as many as three perforations of the diaphragm. A strange observation which they had made was that where there is a penetration of the diaphragm, no matter how high the incision was inflicted, there was no wound of the lung.

DR STUART W HARRINGTON (Rochester, Minn.) had never seen a hernia of this type. In his experience of sixty-one cases of diaphragmatic hernia, fifteen of the herniæ were of traumatic type. Of these fifteen, ten were caused by the indirect force of increased intra-abdominal pressure resulting from crushing types of injury, five were the result of direct injury to the diaphragm. Two of the five herniæ mentioned were caused by gunshot wounds, one by a knife wound, one by a left subphrenic abscess rupturing through the diaphragm into the lung, and the fifth evidently either by trauma from a tube introduced into the pleural cavity at the junction of the diaphragm for drainage of empyema or by trauma from the irritation of the cut ends of the resected ribs. This latter case somewhat simulated the case Doctor Eliot has reported. The thoracic wall bulged slightly at the site of the scar which remained after drainage of the empyema, but the bulging was not caused definitely by the herniated viscus, which was the stomach. The stomach had passed through an opening in the diaphragm close to the costal wall, and immediately proximal to the scar, but it had passed on higher into the thoracic cavity until about a third to a half of the stomach was within the pleural cavity. The case in which the hernia resulted from a ruptured subphrenic abscess is probably the most interesting and rare of the group, for he had found no similar case reported in the literature. The subphrenic abscess was caused by an acute abdominal infection, probably a ruptured appendix, the patient was ill with a septic type of fever for several weeks, and during a violent attack of coughing expectorated about 1,000 cubic centimetres of pus, following which he completely recovered, and four weeks later he left the hospital, to which he had been taken. After about four to six weeks he began to complain of indefinite gastric distress and pain immediately after meals. This became progressively worse later, and was associated with vomiting, which progressed to almost complete gastric obstruction and resulted in gastric tetany. He had lost about twenty pounds at the time of his admission to the clinic. Röntgenological examination was not helpful in establishing the diagnosis, for it appeared in the röntgenograms that the stomach was adherent to the diaphragm. At operation it was found that practically the entire stomach had herniated through an opening in the posterior median portion of the left dome of the diaphragm. The stomach was replaced in the abdomen, and the hernial opening in the diaphragm was closed, with complete relief of symptoms.

DR. KELLOGG SPEED (Chicago, Illinois) in 1916, while working with the Twenty-Third General Hospital, A. E. F., France, said they had a chest ward of thirty beds

constantly filled with battle casualties. He recalled two that fit in somewhat with Doctor Eliot's description. One was a bayonet wound which, on the fourth day after reception, without discharge or infection caused the patient distress and cough and some cyanosis. There were no X-ray facilities at the time to examine it, but on suspicion the speaker opened the chest in a long, curved wound around the eighth rib and found a long tear in the diaphragm. This was sutured with catgut and the patient made a recovery but developed an empyema which was later drained. No hernia of the diaphragm followed although it might easily have developed if suture had not been performed.

The second case was a shrapnel wound between the seventh and eighth ribs near the posterior axillary line. The patient went about a week before he developed serious symptoms. Then a swelling appeared. This went on to redness, and eventually necrosis, and from it poured out faeces. The patient had developed a rupture of the diaphragm, the transverse colon or splenic flexure had passed up through and eventually ulcerated through the shrapnel channel. He had a fecal fistula in the seventh interspace near the posterior axillary line.

DOCTOR ELIOT (closing the discussion) remarked that mention of any unusual or rare condition frequently brings to light one or more similar cases. Thus, recently a case of hernia of the lung following resection of the lower ribs for empyema has been called to his attention. It was indeed difficult to understand why such a hernia was not of more frequent occurrence.

The cases mentioned by Doctors Harrington and Speed were evidently not associated with hernia through an intercostal space. The importance of distinguishing between such a hernia and prolapse was referred to in the paper. The former condition is not uncommon either with or without penetration of the diaphragm. If limited to a prolapse of the lung, immediate reduction and retention is usually possible. If complicated by prolapse of one or more abdominal viscera exploration and possible repair of the resulting damage may be necessary. Penetrating wounds of the chest without prolapse are preferably treated conservatively. The associated hemothorax can be usually successfully aspirated if there is dyspnoea. If aspiration fails, the blood clot can be removed through a simple incision under a local anesthetic. In some twenty-five cases treated conservatively during the recent World War in Evacuation Hospital No. 11, no instance of infection occurred and the results were uniformly satisfactory.

## DUODENAL STASIS DUODENO-JEJUNOSTOMY

BY EUGENE H. POOL, M D , WALTER L. NILES, M D ,  
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OUR motive for presenting the subject of chronic duodenal stasis and its surgical treatment is that the condition is not given its proper weight or balance in the minds of most clinicians.

Stasis of the duodenum definitely occurs, it may cause serious and prolonged symptoms leading to chronic invalidism, the trouble may be corrected by timely surgery. This statement will doubtless excite immediate contradiction for in most medical communities clinicians' eyes are closed to the possibilities of such a condition. Their eyes and minds circulate around the periphery but do not focus on the hub. Cases with definite stasis in which the symptoms indicate treatment and at times operation are overlooked. The impression is extensively accepted that 'duodenal stasis is not a clinical entity but a radiological sign seen in various conditions such as cholecystitis, duodenal ulcer, etc. On the other hand in a few instances there seems to be an undue bias towards the condition, too much is attributed to the duodenum so that it is the first thing looked for and at times the only thing seen. Under these conditions there is too much duodenal surgery. In a word, the condition is not generally given its proper value and it is upon this that we wish to dwell.

The cases may be divided into three main groups.

(1) Fixation, distortion or compression of the first or second portions of the duodenum by bands or adhesions, notably by extension or modification of the hepato-duodenal ligament. These may produce a mild irritation with transient stasis and reversal of peristalsis. (Niles<sup>38</sup> Kantor<sup>32</sup> Shattuck<sup>42</sup> and Imboden<sup>42</sup>.)

We have had considerable experience with this type and have had favorable results by division of bands and by mobilizing and depressing a high fixation or angulation of the duodenum.

(2) Temporary loss of tone with impairment of the function of the duodenum is not uncommon. It results from infections, fatigue or emotional upsets.

(3) Obstruction at or near the duodeno-jejunal junction.

We will confine ourselves to this third group which is sufficiently definite to warrant analysis.

deBeule<sup>17</sup> in 1931, presented a comprehensive discussion of the causes of chronic duodenal stasis. The following is a summary of his classification.

(1) Mechanical obstacle, (2) duodenal paralysis by inflammatory process, (3) disequilibrium of innervation of the duodenum.

(A) Mechanical obstacle

(I) *a* Intrinsic, due to congenital malformations (rare), atresia, angulations and volvulus due to long duodenum

*b* Intrinsic, due to acquired lesions Cicatricial contraction following ulcer, benign tumors, malignant tumors

(II) *a* Extrinsic, congenital, membranes, folds (adhesions) These are called by Duval<sup>22</sup> stenosing periduodenitis, above the thickened colon and retracted hepatoduodenal ligament, submesocolic, membranes at or over the duodeno-jejunal junction (Mayo,<sup>36</sup> Duval<sup>22</sup>) or over the angle between the third and fourth portions (Taylor<sup>45</sup>), retraction of Treitz's muscle

*b* Extrinsic from acquired lesions Compression, stenosis, angulations due to periduodenitis, compression by mesenteric pedicle

The duodenum, lying between the aorta and superior mesenteric artery may be compressed by the latter Conditions bringing about these results are abnormal shortness of the mesentery (rare), and, more particularly, enteroptosis

(B) Stasis through duodenal paralysis caused by inflammatory process (duodenal ileus)

Intrinsic duodenitis

Extrinsic cholecystitis, pericholecystitis, possibly due to distant infections as appendicitis, entero-colitis, pelvic infections de Vadder<sup>19</sup> holds that compression may be due to the lymphatics, lymphatics passing anterior and posterior to the duodenum produce paralysis of the duodenum by toxins from elsewhere

(C) Stasis due to disequilibrium of the duodenal innervation There exists a series of cases where stasis is provoked sometimes by spastic contraction at different levels of the duodenum, sometimes by pronounced atonic flaccidity of the wall, without either local or distant obvious cause It is a question whether duodenal spasticity corresponds to a form of vagatonia, and whether atony is related to sympatheticotonia In two cases, in which the syndrome of duodenal stasis appeared at irregular intervals, and the radiographs indicated no notable arrest in the duodenal transit, intervention showed a greatly dilated duodenum especially at the genu inferior with large retention of duodenal contents Duodeno-jejuno-stomy was of great benefit in both cases

*Historical*—In 1900, Petit<sup>39</sup> described a case of chronic compression of the duodenum by the mesentery which is said by Duval, Roux and Beclere<sup>22</sup> to be the first report of such a condition In connection with this case Petit worked out on the cadaver an operation for duodeno-jejunal anastomosis

That the condition was recognized previous to this has been shown by Bockus<sup>12</sup> in a good review of the subject He states that Rokitsky,<sup>41</sup> in 1849, was the first to suggest that compression of the duodenum by the superior mesenteric vessels might be responsible for dilatation and stasis within the duodenum Kellogg<sup>33</sup> refers to case reports of duodenal obstruction by Boener,<sup>13</sup> in 1752, and by Yeats,<sup>49</sup> in 1820, which are of historical interest In 1889, Glenard<sup>77</sup> suggested that the drag of a dilated ptosed stomach causes at times a dilatation of the duodenum Kundrat<sup>4</sup> (1891) described cases

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of persistent incomplete obstruction which he attributed to compression by the root of the mesentery Albrecht<sup>1</sup> (1899) spoke of it as duodenal constriction due to mesenteric traction

In 1900, Robinson<sup>40</sup> described his impressions gathered from a study of thirty autopsied cases he states that in subjects with visceral ptosis and coils of intestine in the pelvis, the superior mesenteric artery and vein compress the transverse segment of the duodenum and cause dilatation of the part proximal to these vessels He attributed many deaths indirectly to duodenal occlusion in people over forty-five, particularly multiparæ Connor<sup>10</sup> (1906) estimated that two-thirds of a large series of cases of acute dilatation of the stomach had a concomitant dilatation of the duodenum

Bloodgood,<sup>30</sup> in 1907, discussed three fatal cases of gastromesenteric ileus in all of which obstruction began abruptly at the junction of the duodenum and jejunum beneath the mesenteric vessels He suggested that in such cases a duodeno-jejunostomy may be indicated Stavely,<sup>41</sup> in 1908, performed the first duodeno-jejunostomy on a living patient This was done in a case of chronic gastro-mesenteric ileus and proved successful

We will not discuss such procedures as gastro-enterostomy, which has no indication, nor resection (Bloodgood<sup>30</sup>) or plication of the colon (deBeule<sup>17</sup>), which have been employed Resection of the colon was suggested (Bloodgood<sup>30</sup>) on the basis that at times the pull on the mesentery of the small intestine by a prolapsed cæcum may be the cause of the obstruction

In 1913, five years after Stavely,<sup>41</sup> Bartlett<sup>9</sup> did the second duodeno-jejunostomy using a Murphy button to relieve a vicious circle In 1921, Kellogg<sup>33</sup> stated that the total number reported to that date was fifty-eight with no mortality In 1927, Kellogg reported a series of seventy-seven with two deaths The late results were reported as satisfactory A number of other series have been reported

Wilkie,<sup>45</sup> 1927, sixty-four operations, with 6 per cent mortality

deBeule, 1931, a series numbering eighty with excellent late results and only one death He calls attention to cases of duodenal stasis secondary to extrinsic inflammatory processes, cholecystitis, appendicitis, metritis or inflammation of adnexa and believes that the stasis may regress after local operations, but at times he combines the local with duodeno-jejunostomy

DeVadder, 1928, twenty-six operations

Weiss,<sup>46</sup> in 1925, reported thirty-four cases with careful analysis of results In twenty-five, duodeno-jejunostomy was done with twenty excellent results, two fair, one recurrence after improvement, two lost track of This closely corresponds with the usual reports of results

Friedenwald, Morrison and Feldman<sup>20</sup> report on twenty-four cases, eighteen of whom were males and six were females, in contrast to the statement of most authorities that this affection occurs twice as frequently in females as in males The ages of the patients lay between twenty and sixty Twenty-three of these patients were treated by medical measures with at least satisfactory temporary relief In a single case, which resisted this form of treatment, duodeno-jejunostomy was followed by complete recovery Medical management they state is quite satisfactory especially in those cases due to vicerptosis

Appelmans, Van Goidsenhoven and Bone<sup>4</sup> reported twenty-nine cases of chronic stenosis, due to different causes, twenty of which were treated by duodeno-jejunostomy

In fourteen cases caused by compression by the mesenteric artery, there were ten very satisfactory results, two fair results, and two operative deaths In the six other cases associated with pericholecystitis, ulcer, appendicitis, and stenosing duodenitis, there were five good permanent results, and one temporarily good result, followed later by death The total results in the twenty cases are, therefore, fifteen satisfactory results, two fair results, two operative deaths, and one death after six weeks

The reasons for lack of success have been analyzed by Delbet,<sup>38</sup> he states that sometimes the duodeno-jejunostomy permits a supramesocolic stasis to persist, and some-



times it fails completely to aid the difficulty in evacuating the stomach, which so often accompanies duodenal stasis. To obviate these inconveniences, he says, combined operations have been done, duodeno-jejunostomy associated with liberation of adhesions, duodeno-jejunostomy and gastroenterostomy performed simultaneously. But even with operations as complex as these the complete cure of the patients is not obtained. For this reason Delbet conceived the idea of a large anastomosis between the stomach and the duodenum, on the one hand, and a jejunal loop, on the other. This operation he has termed "gastro-pyloro-duodeno-jejunostomy." Incision is made in the pyloric vestibule, the pylorus and the first portion of the duodenum and anastomosis is here made with a loop of the jejunum. In this way there is assured a good evacuation of both the stomach and duodenum. This operation has been performed by Delbet or his pupils almost 100 times. The three cases of death reported in a study of the first fifty cases remain the only mortalities. Delbet believes the results of this operation are superior to those given by the other methods.

Kellogg 1933 has brought the subject to date and reports some seventy-five duodeno-jejunostomies.

*X-ray as a Diagnostic Aid*—The diagnosis of duodenal stasis by the aid of X-ray examination requires special consideration of the anatomy and physiology of this portion of the alimentary canal.

The duodenum is largely retroperitoneal. It possesses no mesentery and is relatively fixed in position. It is the widest part of the small intestine, the average width being four centimetres or more. It is also the shortest segment, being only twenty-five centimetres in length. It lies in close proximity to important abdominal viscera, liver and pancreas, both of which drain into the second portion of the duodenum.

The duodenum and the remainder of the small intestine bear the same relation to habitus as do the stomach and colon, *i.e.* to contour, tone, motility and disease. These variations of habitus, we have been led to believe, are hereditary and more or less fixed, but we are coming to realize that they may vary widely depending upon good nutrition and health.

The duodenum functions in all of its various digestive measures principally as the receptacle for the digestive secretions and the channel through which the chyme is carried into the jejunum. In close relation to this process is the rich blood supply and the delicately controlled sympathetic nervous system which have to do with absorption, secretion and motility.

Normally in a sthenic individual the opaque meal remains in the cap only six to eight seconds, is discharged and makes its entrance into the jejunum in about eight to ten seconds. At the beginning of a meal it is not uncommon to see some disturbance of this normal duodenal rhythm such as puddling and cradling in the dependent portion and occasionally there is reversal of the peristaltic waves. Again at the end of a meal one may observe similar reversal of peristalsis. Some observers believe the duodenal contents are normally regurgitated into the stomach as a neutralizing process of the excess hydrochloric acid.

Alvarez<sup>3</sup> has pointed out that there is a balance between the emptying of the stomach and the holding back tendency of the small intestines. It appears that anything that stimulates the upper intestine will delay the emptying of

the stomach and conversely anything that stimulates the stomach will cause it to empty faster, thus throwing an increased load on the small intestines and especially the duodenum. From this supposedly normal there are many variations, some of which border on disease.

It is well recognized that a partial obstruction of the duodenum, even though it be of an intermittent type may be sufficient to disturb this highly specialized and sensitive mechanism of motility whereas a more complete obstruction in the distal segments of the colon would go unnoticed. As Alvarez has stated the gradients are steeper in the duodenum.

Dragstedt and Dragstedt<sup>21</sup> have demonstrated experimentally on dogs that extrinsic pressure on the duodenum equivalent to as little as six inches of water pressure is sufficient to cause death of the animal. Under such circumstances one might well understand that constriction from adhesions, bands, or pressure from the superior mesenteric vessels when in the upright position may in certain instances produce distressing symptoms.

It becomes apparent that the normal duodenal functions may be upset mechanically either by rapid emptying of the stomach or by narrowing of its lumen. In many instances, no doubt, the combination of these two factors is responsible for a break in the compensation of the duodenal function.

*Symptoms*—Every case complains of indigestion, varying in severity from time to time. The symptoms are heaviness, weight or fullness, chiefly after meals, and usually soon after eating. This is often described as gas, and belching gives temporary relief, though some patients report that they feel as if they would be relieved if they could eructate, but are unable to do so. Some have soreness in the epigastrium and a few describe a twisting sensation with rumbling and gurgling. There is frequently distention of the epigastrium. Nausea is a variable symptom but most patients complain of it at times, though vomiting is unusual. Some complain of fullness while eating, sometimes after taking only a few mouthfuls of food. Small meals can often be taken without discomfort though large meals will produce severe indigestion.

Attacks of pain in the epigastric region are described by about one-half of the cases (nine out of eighteen in our series). The pain is occasionally very severe, sometimes requiring morphine for relief, and has been mistaken for biliary colic. It usually lasts for several hours, sometimes for days, and is frequently accompanied by vomiting. In one case the attack was so severe that the patient was sent to a hospital where a diagnosis of acute intestinal obstruction was entertained. These painful attacks are usually precipitated by fatigue or emotional crises rather than by indiscretions in diet.

Several patients observed that they were more comfortable when they remained recumbent after their meals and that the upright position made them feel weak, sometimes faint and nauseated. We have not observed that lying on the right side or assuming the knee-chest posture gave any more relief after meals than lying on the back. Headaches with a "gone feeling" in the pit of the stomach frequently accompanied the indigestion but these sensa-

tions disappeared when the indigestion was relieved. These symptoms are also frequently reported by patients with congenital high fixation of the duodenum.

Although constipation occurs in most cases it is not very severe generally and in a few the bowels have been irregular in action with occasional loose movements.

The duration of the history is usually a matter of years but it depends upon the age of the patient. Unlike congenital high fixation of the duodenum it seldom goes back to infancy or early childhood and in none of our patients have we elicited symptoms earlier than the age of fourteen. Most of them began in the latter part of the second decade or in the third decade of life. A woman aged fifty-eight never had indigestion until six months previous to examination when the usual symptoms came on after a period of severe mental strain. Several patients were unusually strong and well-nourished during infancy and childhood. The onset of symptoms is usually precipitated by an exhausting illness or by some psychic trauma or emotional strain. One of our patients is a nurse who stood three years of hospital training without a sick day but succumbed to the strain of directing a foreign hospital. Another dates her illness from the Great War, when her husband was reported missing for one month. A young woman began to have attacks of pain while involved in a hectic love affair.

All patients with this disorder lose weight and most of them become very thin—five of our operated cases weighed less than one hundred pounds at the time of operation.

The first impression at the initial examination is that they are hyposthenic types but it is our belief that they are not generally of that habitus. We have seldom found any considerable degree of visceroptosis upon physical or X-ray examinations and we have been impressed by the fact that when they have gained weight after operation or other treatment they do not represent the hyposthenic type at all. A patient who weighed ninety-eight pounds at operation and whom we classed as hyposthenic now weighs one hundred forty-five pounds and would be classed as hypersthenic. We have come to believe that the *habitus enteropticus* chiefly represents emaciation and loss of muscle tone.

Another constant feature of this group of cases relates to the psychic and nervous systems. They invariably develop instability of the sympathetic nervous system and, if unrelieved, always become psychoneurotic. The longer the history of indigestion the more profound the instability of the psyche. Two of our patients have been considered psychotic and all in whom the symptoms have persisted more than a year or two have been neurotic. Not one of our patients has given a history of nervous or mental instability previous to the onset of indigestion. The common symptoms are fatigability, headache, nervousness, palpitation, weakness, insomnia and anxiety, occasionally developing fixed ideas of inadequacy with depression. These

psychoneurotic trends seem to us more constant and more profound than in any other disorder of the digestive tract

The appearance of a chronic case is very suggestive. There is often a muddy pallor of the skin which, combined with emaciation and weakness, suggests chronic intoxication. Mild to moderate secondary anæmia is the rule and three of our patients have had a slight elevation of temperature which has persisted for months and years. One patient is known to have had a slight fever ( $99^{\circ}$  to  $101^{\circ}$  F) for five years. Two of our cases developed definite attacks of tetany.

These symptoms raise the question whether some toxic substance is absorbed from the duodenum. One recalls that dogs die, apparently from a non-bacterial intoxication, within a few days after a closed duodenal loop has been made, and it is an attractive theory that in duodenal stasis toxins are absorbed which produce profound effects upon the nutrition and the nervous system. It is our belief, based upon repeated fluoroscopical examinations, that the duodenum may lose its tone in the absence of any definite pathology and that the resulting stasis may produce indigestion, headaches *etc*, which pass off when the duodenum regains its functional capacity. It is possible that people with a certain degree of organic obstruction may have no symptoms so long as the tone of the duodenum is good and can overcome or compensate for the slight obstruction. This surmise offers a reason why patients with organic partial obstruction may be free from symptoms until the muscular or nervous tone of the digestive tract becomes impaired. When that occurs it becomes increasingly difficult for compensation to be restored.

Aside from the evident malnutrition and asthenia there is little to be found upon physical examination. The patient usually is pallid and the skin is dry and rough. A variety of skin diseases may be noted such as *acne simplex* or *acne vulgaris*, *acne rosacea*, and *eczema*. If the history of indigestion is long, one often finds scars of previous abdominal operations (eight out of eighteen in our series) and sometimes the scars are multiple. A moderate distention is usual, particularly in the epigastrium, and upon pressure one frequently elicits tenderness at a point just above and a little to the right of the umbilicus. Gurgling is occasionally found upon manipulation at this point. We have not been able to outline any diagnostic areas of tympany such as have been described by some authors. The patient is obviously nervous and the reflexes are usually over-active.

In order to detect radiographically factors that produce symptoms it is highly advisable to outline the duodenum in its entirety. In the hypersthenic and sthenic types it usually falls into view, but duodenal stasis is unusual in these types. In the hyposthenic and asthenic types, in which duodenal stasis is common, the third portion of the duodenum usually lies behind the stomach.

Various ingenious methods have been devised for visualizing the duodenum in these types, one of which was to obstruct the distal segment of the duodenum by a balloon attached to a duodenal tube, then injecting barium

into the proximal duodenum through this tube. This method is not advisable because of the distressing symptoms produced. The motility of the duodenum is often disturbed, barium being at times regurgitated into the stomach. The findings as a rule are misleading. Case has suggested that the duodenum can be visualized fluoroscopically by compressing the duodeno-jejunal junction against the spine with one hand and forcing barium through the pylorus with the other and examining in the first (R) oblique position.

These methods have advantages in eliminating or demonstrating the presence of certain organic lesions of the duodenum but are of little value in the diagnosis of duodenal stasis in most instances because the motility is disturbed and it is upon this that the diagnosis largely rests.

*Method of Examination and Radiographic Signs*—We have developed a routine that all patients who give a clinical history suggestive of duodenal stasis be studied both fluoroscopically and radiographically in the vertical and prone positions, more emphasis being placed on the vertical position and the fluoroscopic observations.

The entire duodenum is kept in mind as a possible location or seat of the symptoms complained of, not only its contour but more especially its function, its disturbed motility being the first important diagnostic sign. Fluoroscopists generally have been trained to examine the stomach and cap with great accuracy but the second and third portions of the duodenum do not enter their field of observation unless some very pronounced constant defect is present, such as a diverticulum.

The duodenum can be visualized routinely in most cases by forcing a small quantity of barium through the pylorus into the duodenum after one or two swallows of a barium meal has been given. The pylorus is usually taken by surprise and the barium can be seen to course through the duodenum in normal fashion. This same procedure is again repeated at the usual four-hour examination, forcing the small quantity of barium that may be left in the stomach into the duodenum. If the stomach and duodenum are empty allow the patient to take a couple of swallows more of a motor meal and re-examine the duodenum. Then refill the stomach and note the tone and motility of both the stomach and duodenum. This four-hour observation appears to be the more informative of the two. If the duodenum is normal a more uniform rhythm is present as a rule, if abnormal, the disturbance is more likely to be detected at this time not only by the disturbed motility but by the poor tone or atony which may represent a failing compensation. In advanced cases atony of the stomach is a frequent observation at this examination.

This routine was arranged especially for ambulatory patients which probably covers 95 per cent of this group. A hospital patient remaining in bed would be unlikely to show many positive findings unless the obstruction was more complete or of longer duration.

Partial obstruction of the first or second portions of the duodenum due to adhesions or bands produces various deformities of the cap and may be

difficult to differentiate from ulcer or gall-bladder disease. However, when the combined screen and film examination is carried out, as given above in combination with the Graham test<sup>\*</sup> one is able to study the gall-bladder function in relation to that of the duodenum.

In congenital bands or so-called duodenal fixations, the cap may be constricted and pulled either to the right or left, the right being more common. But usually the cap is large and fills poorly, more particularly on the lesser curvature near the apex. The apex may appear pinched or constricted making the cap discharge its load with difficulty and it usually does not empty more than half of its content. The angle at the first and second portion of the duodenum may appear as a two-peak effect and shows little or no change from the prone to the vertical position. On assuming this position the stomach descends varying distances, placing traction on the cap, elongating it, and accentuating the angle at the junction with the second portion of the duodenum.

In these large flabby caps, where partially empty, the base on the greater curvature may fall in such a position as to give the impression of a duodenal diverticulum, so-called false diverticulum, and an erroneous diagnosis of ulcer may be made from the films.

The second portion of the duodenum will frequently be seen to form a straight line with the liver edge producing a wide loop to the right of the stomach. The lumen may appear constricted and irregular. It may be sufficiently narrowed so that at times the emptying of the stomach may be interfered with. Occasionally when the second portion of the duodenum is adherent to the liver edge a sharp angulation may result from the fixed upper and the free lower portions. Obstruction involving the distal portion of the second segment is occasionally seen in stenosis secondary to ulcer. This condition is best differentiated from extrinsic pressure by not being influenced by posture and is usually seen as a constant defect.

The constant presence of gas in the second or third portions of the duodenum at the three-hour, six-hour, twenty-four-hour, and forty-eight-hour examination or in flat plates of the abdomen is of some diagnostic significance.

Obstruction involving the third portion is usually due either to pressure from the superior mesenteric vessels or an obstructing angle at the ligament of Treitz. This can best be demonstrated fluoroscopically by the above described technic, observing frequent or a continual interruption of the peristaltic rush through these segments producing an abnormal puddling and cradling of barium in the dependent loop. If due to extrinsic pressure the obstruction is usually relieved when in the prone position. This observation cannot be made with any degree of certainty from the films alone. The puddling and cradling in the minor cases may be interpreted as a peristaltic

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<sup>\*</sup> A few preliminary plates of the gall-bladder region may be made, the gall-bladder dye having been given the evening before. Follow by giving the barium meal to which a little cream has been added.

wave that would normally pass into the jejunum. If the films are made in the prone position they are usually non-informative due to pressure defects.

If a greater degree of obstruction is present the dilated duodenum with wide transverse enteric markings may be seen at the three- or six-hour examination. Retention of barium in the duodenum at the six-hour examination is rare in contrast to the other diagnostic signs. This time-honored sign, while of great significance as far as the stomach is concerned, has been responsible frequently for the oversight of abnormal duodenal function.

As to difficulty of diagnosis the following case may be cited.

A girl of twenty-one was admitted in 1924. She had never been well, headache almost every day, slight rise of temperature almost daily for last five years. Subject to respiratory infections, colitis, dysmenorrhœa. For three years attacks of severe cramp-like abdominal pains lasting five to six hours. With the cramps tympanitis and headaches.

She consulted almost every prospect in this country and abroad, being practically bedridden for about five years as result of asthenia and headaches.

X-ray showed the second portion of duodenum distended and "writhing" with reverse peristalsis and puddling.

The interesting feature of the case is that no one thought of the duodenum. Finally Dr. Benjamin Michailovsky recognized the condition as shown in the plates which everyone had viewed but no one had attached importance to. He advised operation but the writer counselled "more evidence." Within a few days typical gastric tetany developed. Duodeno-jejunostomy was performed. The result has been admirable.

As to repeated operations. (H. T.) Admitted 1926. Woman thirty years of age. Chief complaint vomiting for five months. Three years ago had convulsions, twice in a sanitarium for three years. Has had respiratory infections, palpitation, dyspnoea, constipation and loss of weight. Five months before admission there occurred an attack of severe vomiting lasting three days, with loss of sixteen pounds. Since then has vomited once or twice daily. No pain, but sense of pressure in lower right quadrant.

Appendectomy performed. She continued to vomit daily until daily lavage was instituted. Readmitted one year later. The symptoms had continued, nausea, vomiting, flatulence, abdominal distress. Exploratory duodenum held high by very dense adhesions. These were freed so as to mobilize and depress angle of duodenum.

Symptoms continued in spite of constant and careful medical treatment. Two years later re-admitted. X-rays showed duodenal stasis. duodeno-jejunostomy resulted in cure of digestive complaints.

*Treatment*—We wish to state emphatically that it is not necessary or wise to operate upon every patient who suffers with duodenal stasis. We have previously expressed the view that temporary loss of tone with impairment of function in the duodenum is not uncommon and it is our experience that some patients with fairly long-standing histories may be relieved of their symptoms and restored to health. However, the longer the history of indigestion and the more severe the loss of flesh and strength the less probability of relief without operation. Also, those who have had painful attacks seldom improve materially without operation.

The decision whether to advise operation demands most careful consideration and cannot be made without taking into account the nervous and psychic state as well as the physical. No set rules should be followed. Probably no

patient should be subjected to operation before a medical regime has been given a thorough trial. However, most of our patients had already tried a variety of cures and diets without satisfactory or permanent improvement.

The factors which make us incline toward advising operation are (a) uncontrolled indigestion for many years (b) progressive loss of weight and strength, (c) pronounced dilation and stasis in the duodenum demonstrated by X-ray examinations, (d) progressive psychoneurosis which followed the onset of symptoms, and (e) young patients. In the younger patients we are more inclined to advise operation with less severe symptoms and less marked stasis than in older patients because we believe that otherwise they will probably suffer progressive impairment of health and usefulness and because the results are prompt and satisfactory. The cases with profound psychoneuroses offer a particularly difficult problem. Here the family history, the environment and the psychic pattern of the patient have to be studied and evaluated in relation to the digestive system. In many instances we have been presented with clear histories of the development of nervous symptoms long after the onset of indigestion and we regard this as an indication for operation as the first step in effecting a cure. Most of these cases spontaneously regain stable nervous systems but a few require psychical reeducation.

The principles underlying medical treatment are to reduce the functional burden of the duodenum as much as possible and to improve the physical and nervous tone of the patient. Small feedings at frequent intervals, and rest particularly after eating, are fundamental. It is often best to put the patient in bed for a few weeks, active exercise after meals must certainly be interdicted. The diet should be smooth without roughage or condiments and must be prescribed with due regard to the vitamin and caloric needs of the patient. A hot moist compress over the upper abdomen after eating is helpful in reducing the irritability and spasm of the duodenum. Retention enemas of mineral oil are preferable to cathartics where needed. Alcohol and tobacco are both harmful. Freedom from cares, worry and excitement must be secured as far as possible. After a few weeks of a rest régime the patient should begin to exercise, gradually increasing the duration and severity. Massage may be helpful and fresh air and sunshine are essential.

For further sedative and antispasmodic effect we commonly prescribe phenobarbital and atropine, sometimes with a digestive ferment, in capsules to be taken several times daily. Insulin has been given twice a day before eating in a few cases. This has always resulted in considerable gain in weight but it has relieved the indigestion little if at all. One of our patients gained twelve pounds during two months of continuous treatment with insulin and subsequent X-ray examination showed distinct improvement in the tone of the duodenum with less stasis, but her indigestion continues.

It has been our experience that the only cases that have been distinctly helped by medical treatment are the few with short histories of indigestion and very moderate degrees of stasis as demonstrated by X-ray study.

*Surgical Treatment*—Bands or constricting adhesions should be freed



Duodeno-jejunostomy is indicated for obstruction at the terminal portion of the duodenum. The operation is safe and the results good. Pool has done eleven cases. They have been carefully selected as is suggested by the fact that they cover nine years. The results have been satisfactory, seven excellent, two fair, two doubtful, no mortality. On the other hand, Niles<sup>38</sup> has a personal series of eighteen cases with six operated upon. Under conservative treatment in the non-operative cases the results were satisfactory. This suggests that in carefully observed cases operation is indicated in about one-third.

It is significant that all these cases have been in private practice. In a large public surgical service cases have been looked for for nine years and none found. The reason is undoubtedly that patients enter surgical wards only with fairly definite lesions and these cases remain in medical hands and are not recognized and referred. The number of our series is therefore small.

The details of duodeno-jejunostomy need not be given. The technic of the procedure is outlined in the report of cases.

*Conclusions*—Chronic duodenal stasis caused by intermittent obstruction at or near the duodeno-jejunal junction definitely occurs. The clinical picture is suggestive.

There is a long gastric history. A significant feature is a feeling of fullness or pressure in the epigastrium after meals culminating in nausea. Actual pain at times occurs, vomiting is infrequent. These symptoms occur either in sharp attacks at intervals or are progressive for long periods. There is a periodicity in many of these cases which is dependent upon emotional disturbances or fatigue. A striking general feature is loss of weight and asthenia. Many of the patients are markedly thin and have had repeated abdominal operations. Usually there is tenderness in the epigastrium to the right of the mid-line.

In addition to the above there are usually toxic symptoms which include fever, headache, neuralgia, mental depression, cold extremities, skin eruptions as acne. The patients invariably develop instability of the sympathetic nervous system and if unrelied often become psychoneurotic. Usually the cases have had one or more operations, appendectomy almost always, frequently freeing of adhesions or bands, cholecystectomy or gastroenterostomy. Ultimately some one centres attention on the duodenum. However, the diagnosis is not simple. Reliance must be placed largely on the fluoroscopical findings, though study of X-ray plates aids. The fluoroscopist must be experienced with the condition. Usually operation should be elected only after several X-ray checks, preferably by different observers. The findings at operation are often not conclusive, as the duodenum may be collapsed at the time.

No patient should be subjected to operation before a medical regime has been given a thorough trial. This failing, duodeno-jejunostomy may be elected. About one-third of the cases present striking indications for operation and show proportionate improvement after duodeno-jejunostomy.

## DUODENO-JEJUNOSTOMY

Since the diagnosis of duodenal stasis is made upon symptoms and signs of abnormal physiology without directly demonstrating an organic lesion it requires the most careful coordination of findings by the internist, roentgenologist and surgeon

### CASE REPORTS OF DUODENO-JEJUNOSTOMY

**CASE I**—*Duodeno-jejunostomy, adhesions necessitating secondary operation cure*  
A single white woman twenty-one years of age admitted to New York Hospital, October 8, 1924, with chief complaint of headache and dysmenorrhœa since onset of menstruation at age of fourteen. She has never been well. Headache almost every day, erratic temperature past five years 99–101.5. Dysmenorrhœa marked. A fairly well developed and nourished white female not acutely ill. Examination essentially negative.

October, 1924, D and C. Uterus sharply anteflexed at internal os. Appendix with kink in lower third removed. Uterus found sharply anteflexed but tending to fall back-



FIG 1—(Case I) Dilated duodenum



FIG 2—(Case I) Two hour retention in duodenum

ward. Right ovary presented a cyst about three-quarters inch in diameter, excised. Round ligament and peritoneum imbricated in order to support uterus in more anterior position.

October 18, 1927. Patient again admitted to the New York Hospital. Six months after operation patient had an attack of mucous colitis. Seen by numerous men. Colon irrigations, starvation diet, emetin, ichthyol enemas, milk diet. In December, 1926, a polyp was removed from right antrum. (Figs 1 and 2)

Following attacks of mucous colitis has had attacks of severe cramp-like abdominal pains lasting at times five to six hours. With cramps tympanites and headaches.

Physical examination negative. Barium series showed a normal stomach and normal first portion of duodenum. The second portion of duodenum was distended with "with-ing" and reversed peristalsis. Hourly films showed stomach emptying normally but with definite puddling in the second portion of the duodenum.

December 1, 1927, patient again admitted after having spent the intervening time in bed at home. Symptoms having progressively become more marked.

Attack of typical tetany. December 2, 1927, operation through an incision to right

of mid-line was done Transverse colon lifted and duodenum found considerably enlarged The superior mesenteric vessels fell down over the duodenum almost like a heavy band which was undoubtedly the cause of the obstruction Few nodes in retroperitoneal region A duodeno-jejunostomy was performed between the jejunum, about four inches from the angle, and duodenum just to the right of the superior mesenteric vessels, the opening being about one and one-half inches long Two layers of chromic anteriorly and also posteriorly Convalescence uneventful Patient discharged on thirty-seventh post-operative day (January 8, 1928)

February 23, 1928, patient again admitted Following operation she was entirely relieved of the symptoms which had lasted ten to twelve years One week before admission noticed a slight tingling in her hands This gradually grew worse until she had actual spasms of her hands and feet Tetany Attacks came on about two hours after meals with distress in epigastrium, distention, rapid and shallow respiration, tingling of hands and feet, followed by spasms of hands and feet

Physical examination same as before with recent scar and slight distention in left side of upper abdomen

Barium series showed slight distention of second and third portions of duodenum with very definite puddling in second portion at end of two and three hours The duodeno-jejunostomy was not visualized clearly

March 5, 1928, under ethylene-oxygen-ether anaesthesia, the former scar was excised

Massive adhesions were found Stomach and duodenum presented as a firm, hard mass, the result of very marked spasm in spite of fact that the patient was under anaesthesia As the adhesions were freed, a loop of ileum quite collapsed wriggled out of a fossa formed by adhesions, the loop lying beneath the jejunum just distal to the site of the anastomosis The jejunum was traced downward for some distance and found to be quite normal and no adhesions present Adhesions then dissected so as to examine the anastomosis The proximal portion of the jejunum was normal The portion distal to the stoma was dilated The stoma was dissected out in order to be quite sure of its patency The jejunum was opened distal to the stoma and the finger introduced readily showing a wide open stoma The finger passing up to and through the pyloric ring which was very firmly contracted and thickened Incision closed by three rows of transverse sutures so as not to diminish the calibre of the vessel All denuded areas were then covered with sterile vaseline The pylorus was then incised longitudinally so as to divide the pyloric ring, and the opening repaired transversely, the idea being to prevent subsequent pylorospasm

Convalescence uneventful and patient discharged on fiftieth post-operative day (April 24, 1928)

Present condition five and one-half years after operation weight 103, very little digestive disturbance if she observes a reasonable diet Headaches far less frequent than formerly Bowels regular Very little abdominal discomfort Complexion entirely clear, sleeps well She adds (from Santa Barbara) "the duodeno-jejunostomy withstands even earthquakes"

CASE II—*Repeated operations before true condition was recognized duodeno-jejunostomy cure* A white, unmarried female thirty years of age first admitted to the New York Hospital, September 9, 1926, with chief complaint, vomiting for past five months

Five months before admission had attacks of vomiting which were so severe she was unable to keep any food down for days and lost sixteen pounds Severe vomiting lasted three days, placed on Murphy drip and vomiting stopped to a certain extent Has vomited once or twice a day since No pain but sense of pressure as if from gas in right lower quadrant

A thin woman Slightly enlarged thyroid gland A few constant rales at left apex posteriorly Abdomen negative save for slight tenderness in right lower quadrant Fine tremor of hands and exaggerated knee-jerks X-ray showed a high fixation of the

## DUODENO-JEJUNOSTOMY

duodenum Operation for chronic appendicitis, an appendix four inches long with thick wall showing evidence of definite disease removed She continued to vomit daily until daily lavage was started Discharged on fifty-first post-operative day (November 2, 1926) still being lavaged

Readmitted one year later with much the same symptoms all the time as before operation Troubled by nausea, vomiting, flatulence and some pain in the abdomen Pain frequently in region of appendectomy scar Some burning pain recently over tenth rib posteriorly on right Usually nauseated and vomits two hours after meals Soda does not give any relief but vomiting relieves her Has lost seven pounds in last four months

Abdomen distended and tympanitic Tenderness at right costal margin

*Operation*—Exploratory through high right rectus incision Gall-bladder negative Duodenum held high by very firm, dense adhesions "The most dense I have seen in any case" These were freed so as to allow mobilization and a straight course and more dependent position of angle of duodenum Transverse colon was inspected Normal No ulcer of duodenum or stomach

Patient continued to vomit daily until discharged twenty-three days post-operative (February 16, 1928)

Admitted to New York Hospital for third time two years later (February 2, 1930), again without relief of symptoms About one year ago vomited some small clots of blood Has had a thorough treatment for ulcer (medically) but without improvement

Physical examination essentially negative Careful X-ray of gastro-intestinal tract revealed definite dilatation of the second and third portions of the duodenum with marked writhing, twisting and also some reverse peristalsis Barium enema showed marked ptosis

Admitted to New York Hospital for fourth time, March 2, 1930, for third operation Condition as before Still has occasional attacks of moderate pain in mid-line in epigastrium usually accompanied by vomiting of bile, this vomiting being prevented if lavage is done with onset of sense of nausea Pain seems to be initiated by overeating more than anything else

Physical examination negative *Operation*—Under ethylene-oxygen-ether anæsthesia a transverse incision midway between umbilicus and ensiform and extending to outer borders of rectus made

Stomach seemed normal Many adhesions between gall-bladder and duodenum The jejunum was located at its proximal end and there seemed to be a kink in it only a short distance beyond the ligament of Treitz Duodeno-jejunostomy done with double row of chromic sutures posteriorly and anteriorly, the stoma admitting end of thumb

Course smooth and discharged on twenty-fourth post-operative day (March 29, 1930)

Patient admitted again six months later, December 19, 1930, for pyelitis, having been exceptionally well in the interval

*Results*—"Since my operation of 1930 I have gained about twenty-two and one-half pounds and now weigh about 122½ My appetite is exceptionally good, I can eat everything and enjoy my meals I am troubled with headaches and nausea only before my periods I never have any abdominal discomfort, my general condition is greatly improved"

*CASE III—A striking case in which the true condition was overlooked for fourteen years duodeno-jejunostomy cure*

Male, aged fifty The following series of operations and studies were with one exception carried out by prominent men in other cities

1923, appendectomy, exploratory of the gall-bladder and duodenum Gall-bladder slightly thickened, no adhesions, no stones Not sufficient evidence for removal Duodenum normal

1926, Gastro-intestinal series Stomach and bulb negative Graham test very little dye in bladder Two negative shadows present

1930, gastro-intestinal series Two gall-stones Ptosis of stomach and colon Five hours gastric retention Definite evidence of colitis

September 30, 1932, Doctor R stated "He has an obviously dilated stomach with no organic lesion that I could ascertain and a slight delay without dilatation of the terminal portion of the duodenum" Doctor M gave gastro-intestinal series the following day which was reported negative for organic disease (Figs 3 and 4)

*Present Illness*—Onset fourteen years ago with epigastric discomfort after meals, belching and fullness in epigastrium Symptoms have been intermittent until past six years and almost constant since Best weight 178 pounds fourteen years ago For past three to four years has taken three to four glasses of warm water on arising which induces vomiting Has used stomach tube, which he carries, and uses two to three times a day to get relief Has lost fifty pounds in weight Feels weak Appetite good but has distress after taking food Afraid to eat Feels mass in right upper quadrant after eating, belches almost continuously, frequent severe headaches, relieved on using stomach tube Bowels regular Friends tell him he looks badly Doctors tell him the



FIG 3 —(Case III) Dilated duodenum

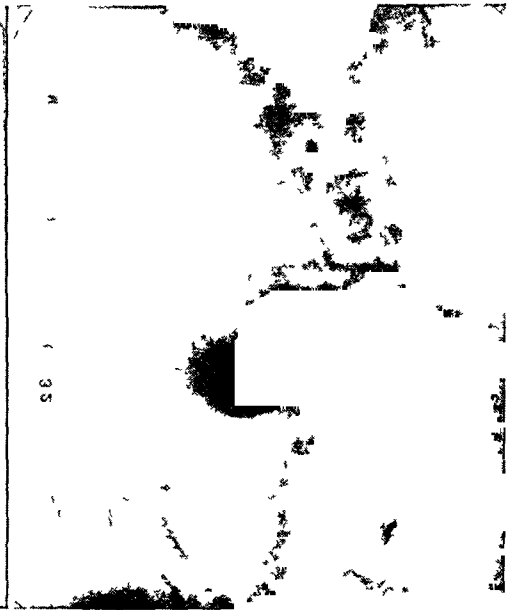


FIG 4 —(Case III) Two hour retention

trouble is in his head On several occasions has felt toxic Temperature frequently 99.8° to 100° Following castor oil always had fever, face swells and unable to close hands

*Physical Examination*—A poorly nourished white man of 120 pounds Stomach and transverse colon low Palpable fluctuating mass in right upper quadrant, at times mass is tympanitic Test meal—TA 80, FA 50 Occasional spurt of duodenal regurgitation Blood-pressure, 100/60, pulse, 80, blood Wassermann, negative May 16, 1932, X-ray and fluoroscopical show duodenal fixation with stasis in cap Duodenal obstruction at angle of Treitz with marked duodenal stasis in third portion Gall-stones Above findings repeated three times

Operation November 1, 1932 (1) Duodeno-jejunostomy for constriction at the duodeno-jejunal flexure (Fig 5) (2) Cholecystectomy for cholelithiasis

Avertin supplemented with ethylene and oxygen (1) A right upper rectus incision was made, an old mid-right rectus incision scar being excised There were many adhesions about the duodenum which were separated *At the duodeno-jejunal flexure there was a definite constriction of the gut just beyond the ligament of Treitz, which seemed to be due to adhesions in this region These were separated Duodeno-jejunostomy* (2)

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The gall-bladder contained two large stones as had been demonstrated by X-ray, cholecystectomy (Fig 6)

*Result*—He has gained about fifteen pounds since discharged from the hospital and his symptoms are much improved, although he is living under very unfavorable conditions

*CASE IV—Marked duodenal stasis one attack of tetany anatomical anomalies duodeno-jejunostomy cure* A white, married female twenty-eight years of age, first admitted to the New York Hospital, March 21, 1932, with chief complaint of attacks of abdominal pain with vomiting

Stomach symptoms since removal of appendix sixteen years ago Infrequent and



FIG 5—(Case III) Obstruction at duodeno-jejunal junction showing sharp constriction as if a string had been tied loosely around the gut (Insert before traction on jejunum to demonstrate the obstruction) First operative step, peritoneum divided, posterior serosal stitch between duodenum and superior surface (not free edge) of jejunum

mild attacks Worse since birth of first baby two years ago Last attack very severe, pain radiated through to back Attack of tetany in March Has no warning of attacks Does not think attacks depend upon character of food Attacks of diarrhoea for past year independent of attacks of abdominal pain Two or three liquid movements daily at times, alternating with normally formed stools No alternate periods of constipation Pain in abdomen is sometimes very severe Vomits very often with attacks Often notices food eaten several meals previous Appetite good No distress in intervals No tenesmus No blood or mucus in stools Some loss of weight Some loss of general strength Sleeps well No headaches No thirst No dysuria

*Physical Examination*—Weight, 103 Abdomen full Somewhat enteroptotic Well-

healed scar in appendicial region Quite tender in right upper quadrant and epigastrium  
Reflexes normal Blood pressure 110/70

X-ray examination October 10, 1932 (Fig 7) Stomach is transverse, fish-hook character, presenting no definite intrinsic pathological process Duodenal cap is visualized, appears symmetrical and regular and emptied in the usual fashion At the junction of the descending and transverse portion of the duodenum there was a marked angulation with puddling of the barium in this area, with a slight tendency to reverse peristalsis The barium passed from this point with rather rapid intensity through the proximal loops of the jejunum in a suggestively irritable fashion The patient examined in the supine

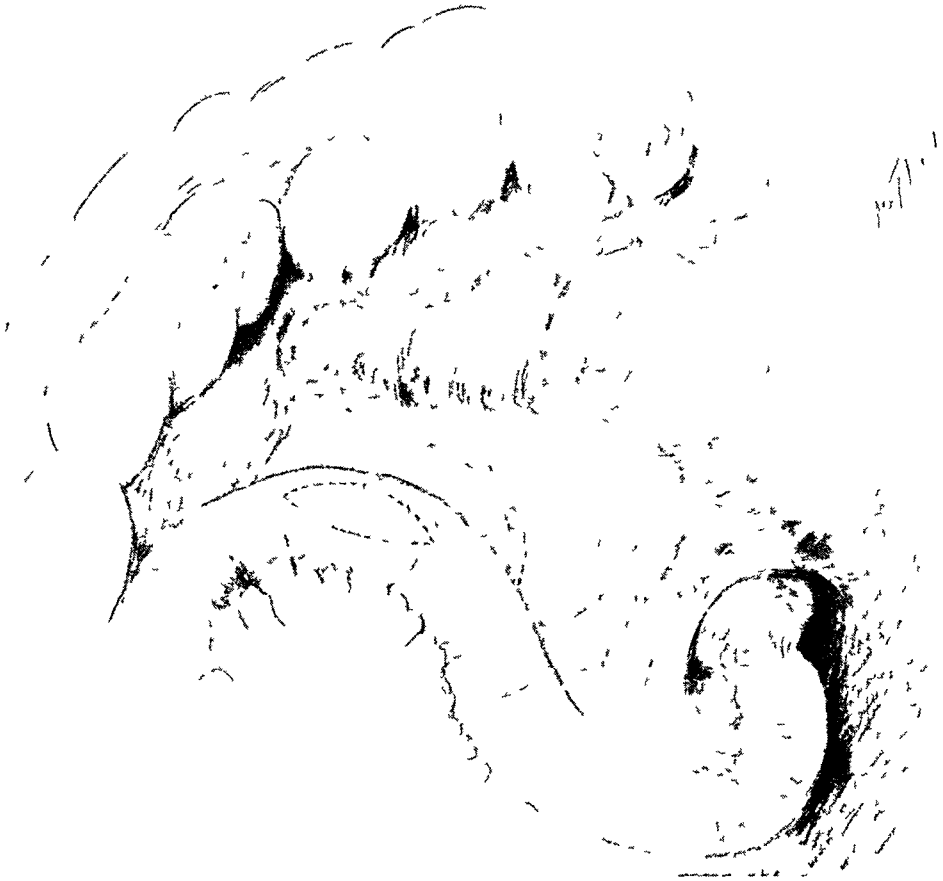


FIG 6—(Case III) Situation of stoma after duodeno jejunostomy

position on the horizontal table showed a tendency to elevation of the distal third of the stomach and slightly outward and creating a curvature as though resting upon the pancreas, the exaggerated mucosal markings of the jejunum suggesting a moderate amount of irritability At the end of four hours there is no gastric residue but the angulation in the duodenum above described still shows the retention of barium, and the head of the column is already in the rectum

Similar findings by Doctor Holland in regard to stasis of duodenum

Duodeno-jejunostomy for partial obstruction of the duodenum, October 18, 1932 Ethylene-oxygen Right upper rectus incision, the duodenum was exposed and a good many adhesions found about it These were separated The first, second and third portions of the duodenum were markedly distended, the beginning of the jejunum being collapsed The point of obstruction was definitely at the duodeno-jejunal junction

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Further examination revealed definite constriction of the duodenum as it passed through the base of the mesocolon. It was decided that a duodeno-jejunostomy was necessary. This was accomplished by drawing part of transverse duodenum through an opening in the transverse mesocolon.

The case presented several anatomical anomalies, the transverse portion of the duodenum was suspended from what could be readily called a short mesentery. There had been failure of the great omentum to fuse with the transverse colon, so that the transverse colon was lying free, there being no gastrocolic ligament. This case represented a very definite obstruction of the duodenum, the duodenum

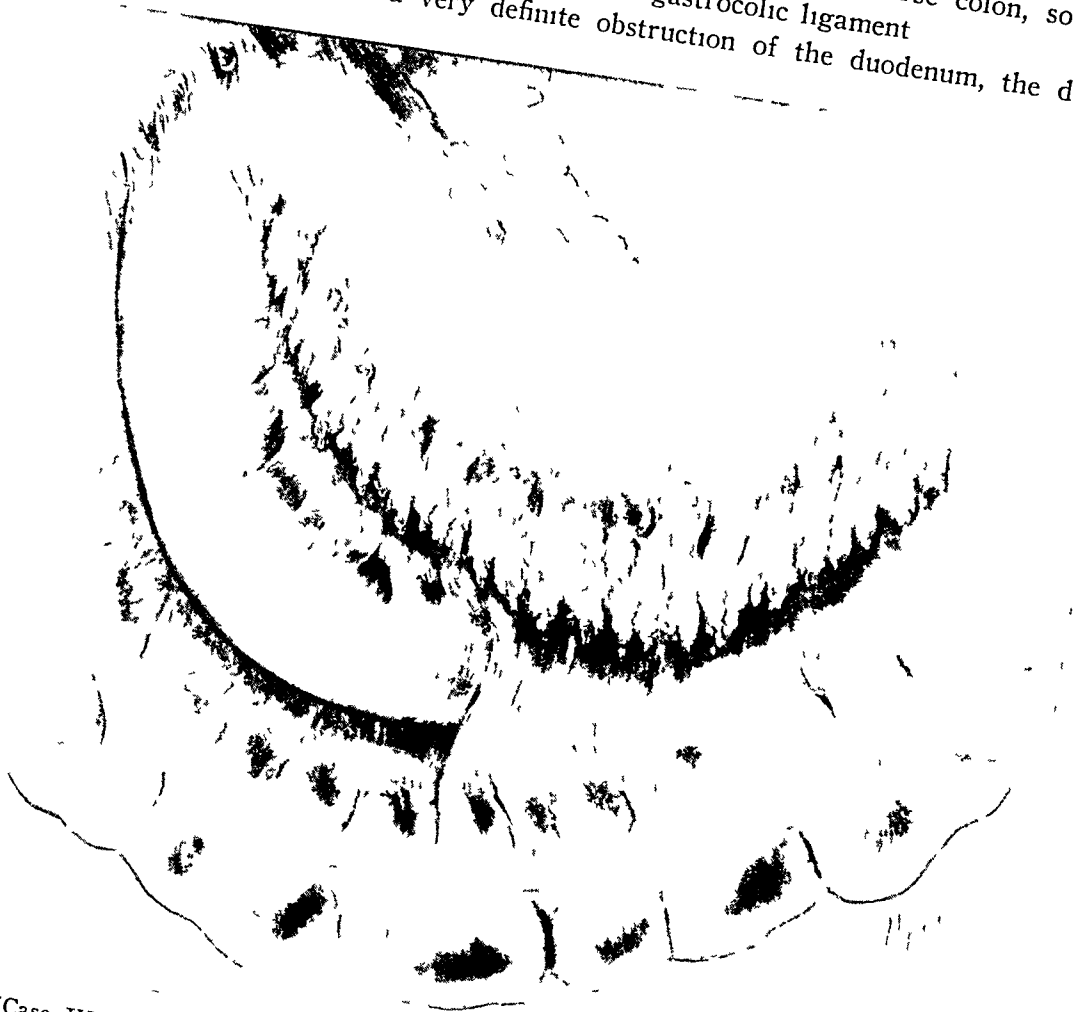


FIG 7—(Case IV) Anomalous condition, no gastrocolic omentum, markedly distended duodenum being fully three times the calibre of the proximal jejunum. At the close of the operation, the jejunum had enlarged in size and the passage of gas was audible (Figs 8 and 9).  
*Result*—April 2, 1933, no digestive disturbance at all, occasional headaches, bowels regular, occasionally some general abdominal discomfort, appetite good, feeling fine. She is still on a restricted diet.

**CASE V**—A nineteen-year-old unmarried male admitted to the private side March 8, 1931, with chief complaint abdominal discomfort and nausea for past four months. At age of eleven had convulsions which have recurred at about three-year intervals. Has been given luminal daily since T & A as a child. In 1928, had an appendectomy, course uneventful. At one time he was said to have a "nervous heart." In 1930, during May, June and July, was jaundiced, which subsided under medical treatment. In 1930, had an attack of sinus accompanied by colds and headaches which gradually cleared up. December 27, 1930, three months before admission, patient had gas pains, enema



returned with good results and much relief. The next day he had a recurrence with nausea. This continued for some time and Doctor Holland was consulted. Patient examined thoroughly, fluoroscoped and X-rayed. Given benefit of treatment with diet, supports and other means but to no avail. Reversed peristalsis having been observed, an operation was advised to find and relieve the cause.

Physical examination showed a well-developed and nourished male adult, with a point of tenderness over an old right rectus appendectomy scar, otherwise negative.

March 9, 1931, under ethylene-oxygen-ether anæsthesia, an upper right rectus incision was made.

Upon opening the abdomen the hepatic flexure of colon was found twisted on itself. Adhesion of omentum to appendix scar and a dilated duodenum.

Adhesions of omentum were severed. Hepatic flexure of colon then readily returned to normal position. Careful inspection of stomach, pylorus, liver and gall-bladder did



FIG 8—(Case IV) Post operative barium passes into jejunum without any accumulation in duodenum. This case was one of the two who had attack of tetany.

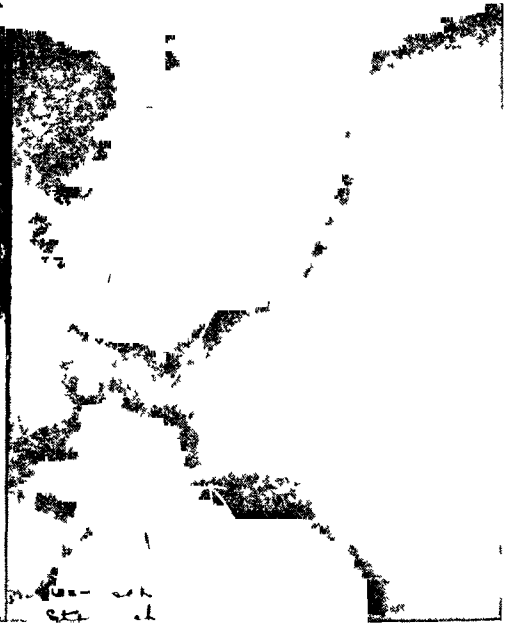


FIG 9—(Case VI)

not reveal anything abnormal. The transverse colon was lifted and the transverse portion of the duodenum inspected and was found to be very definitely dilated. The cause of this could not be determined on account of the large vessels at the duodeno-jejunal junction, but there were no adhesions anywhere in this region. Probably the obstruction was due to the superior mesenteric vessels. An anastomosis seemed definitely indicated. Accordingly, the peritoneum over the duodenum was divided and this portion (transverse portion) of the duodenum mobilized. A suture anastomosis was made between the jejunum about five inches from the duodeno-jejunal junction to duodenum two inches from the duodeno-jejunal junction. Fine linen was used for the external layer. Chromic for the internal suture. The orifice was about two centimetres long. The wound was carefully closed in layers without drainage.

Following operation temperature went to  $101^{\circ}$ , by rectum, came down gradually. Remainder of course uneventful, and patient discharged from hospital on nineteenth post-operative day.

April, 1933, he is reported as in good condition and free from symptoms.

CASE VI—A white married female, aged twenty-eight, admitted to the New York

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Hospital October, 1930 July 18, 1929, chief complaints were pain in the joints, pain in the right side of chest, nausea, vomiting and fatigue Ruptured appendix removed five years ago

*Present Illness*—Two weeks previous began to have pain in the smaller joints of the right hand and ring finger Had some pains in knees but no swelling Has had no sore throats So-called pleurisy eight years ago Repeated attacks of nausea and vomiting, pains in left chest with temperature Suspected gall-bladder some years ago which X-ray showed to be enlarged Repeatedly has had attacks of hives

Latter part of 1929 had an attack of so-called pleurisy X-ray of chest did not show any evidence of tuberculosis, but because of constant recurring pain, it was thought best for her to live out of town After leaving City she had a continuance of her symptoms followed by psychoneurotic breakdown which confined her to a sanatorium for several months

She passed under the observation and care of various men October, 1930, as patient did not improve rapidly, she saw a psychologist who advised removal from the institution and sent her home under care of a nurse Patient did not improve under this change October 10, again consulted Doctor Niles, complaining of stiffness and body soreness, also pain in the occipital region, and difficulty in swallowing Had been running a temperature

Physical examination revealed extensive superficial acne of face, pupils dilated and react promptly, tongue heavily coated, moderate fine tremor, neck shows several palpable nodes in the left posterior triangle, tenderness over occipital region, tender over neck, heart accelerated, no murmurs, lungs negative, abdomen, there is a point of sharply localized tenderness just to the right and below the umbilicus, reflexes hyperactive Weight, 130 pounds Temperature, 100°

October, 1930, confined to hospital where she continued to run a temperature varying between 100° and 101° X-ray examination showed dilatation of the second and third portions of the duodenum with reverse peristalsis (Doctor Martin) The same findings reported by Doctor Holland

October 28, 1930, operation The findings of a distended duodenum bore out the clinical diagnosis A duodeno-jejunostomy was performed anastomosing the jejunum four inches from the angle to the third portion of the duodenum just lateral to the mesenteric vessels The duodenal site of the anastomosis was prepared by dividing the peritoneum transversely and carefully mobilizing the duodenum from the posterior wall and the lower border of the pancreas which was clearly visualized When the peritoneum over the duodenum was divided, the duodenal distension became even more apparent

Immediately after operation patient seemed to improve a good deal Had temperature for a few days which soon subsided Patient complained of discomfort from pains in her head and neck Her intestinal symptoms improved No temperature Gained in weight but still complained of good deal of pain in side of her head and neck This condition was relieved almost completely by drainage of her sphenoidal sinus by Doctor Harper

At different times since her operation she has had some abdominal complaint of pain and occasional attacks of vomiting which last as long as a week Her general condition, however, has been most satisfactory, in as much as her weight has steadily increased, and the condition of her skin has improved very much

The latter part of December, 1932, had an attack of vomiting which lasted for three weeks There were no signs of obstruction so far as the character of vomitus or general condition were concerned She was given a barium meal the latter part of January during an intermittence in her vomiting attacks, and the only abnormality made out at that time was increased motility, the meal being present in the rectum within six hours After this attack she improved and has been able to eat without nausea There has been an increase of weight to 137 pounds

CASE VII—Under observation since 1927, Doctor Cussler writes as follows

Miss — first consulted me in June, 1932 She complained that she tired easily and had some headache, which came on at intervals, frequently lasted several days, and was accompanied by soreness over the eyes and a feeling of nausea This nausea was not active, but gave her a sensation of uncertainty She also had intermittent attacks of pain in the right lower quadrant of the abdomen with a sense of soreness and fullness These symptoms have been present at intervals since 1926 She was habitually constipated and the usual laxatives, mineral oil, *etc*, were ineffective She stated that she had no desire for food

X-rays taken in 1927 and brought to the office with her showed a marked visceroptosis with dilatation of the duodenum She had already consulted a number of physicians without receiving much help

Physical examination was essentially negative The blood-pressure was rather low, 105/65 Hæmoglobin, 75 per cent, with a corresponding number of red cells Weight, 141 pounds Heart and lungs negative

There was slight tenderness in the right lower quadrant of the abdomen No muscle spasm Distinct fullness was present in the left lower quadrant, and the descending colon was felt

She was given advice regarding diet and mechanical laxatives were suggested A binder to correct the visceroptosis was ordered

For a time she felt better and during the Summer remained fairly well

In December, 1932, she returned to the office, and reported that during the Fall the symptoms had recurred Her habits of eating and living were irregular

Gastric analysis shows no free hydrochloric acid before or after meal Stool negative for blood or parasites Gastric analysis after histamine (thirty-five minutes) shows free hydrochloric acid 9 Basal metabolism 17.6

X-ray—Stomach well filled, hypotonic, large vertical, extending to brim of pelvis Peristalsis fairly normal character No gastric defects Duodenal bulb visualized, rather low, elongated and fixed at tip in upright position The descending duodenum is definitely on the stretch, narrow and at the beginning of the transverse portion of the duodenum there is a definite distension and puddling with reverse peristalsis occurring from the ligament of Treitz backwards and upwards in the duodenal bulb Distal to the ligament there is a moderate dilatation of the jejunum and localized spastic areas more or less persistent, simulating bands which are probably referred from the above described duodenum The proximal portion of the duodenum is persistently dilated and presents stasis throughout the examination Twenty-four-hour plate showed barium in sigmoid, appendix visualized low in pelvis, redundant and tortuous and slightly fixed Palpation for tenderness shows this essentially above region of appendix and over descending colon just above sigmoid Pressure at this second point causes pain referred to right side of abdomen Impression—a band in the region of the tip of the duodenal bulb with fixation to the under surface of the liver in the region of the gall-bladder and angulation defect at the ligament of Treitz creating duodenal stasis and referred spasm to the proximal jejunal loops (Kilbane) Barium enema shows irritable colon

Operation—January 20, 1933 A right rectus incision The appendix removed There were a few adhesions around the descending and first portion of duodenum The descending and horizontal portions of the duodenum were seen to be dilated to a moderate extent The duodenum was difficult to deliver for some unexplained reason and the anastomosis was difficult throughout due to the poor exposure of the loop Duodeno-jejunosomy was performed Apart from a wound infection she did well The result to date has been excellent

CASE VIII—A white married female forty years of age, November 7, 1929, complained of vomiting in the morning, no appetite, numbness of legs Alcohol consumption one quart a day Six months previous to this she had a history of fever, some bloating and vomiting The fever lasted about four days, and the gastro-intestinal symptoms about

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two weeks She got along very well from November until she went abroad in the Spring of 1930, having been off alcohol during this time When she got to southern France, she had what she described as the "flu" with temperature three or four days, with vomiting and bloating Could keep nothing on her stomach but brandy In August, 1930, when she was very thin, had no appetite, with some vomiting at this time Summary of the gastro-intestinal series showed no evidence of ulcer or cancer, stomach of vertical type with definite evidence of obstruction at the angle of Treitz as indicated by distension and reversed peristalsis in the descending loop of the duodenum, appendix not visualized, redundancy of the sigmoid, cardiac and pulmonary shadows, normal, small shadow in the lower right abdomen probably representing a calcified node She was put on a diet with more rest and less alcohol (Figs 10 and 11)

In October she was under the care of a neurologist X-rays of the gall-bladder failed to show any shadow of bladder or stone Stomach was normal, as was the duodenal bulb Second and third portions of the duodenum were distended and constantly



FIG 10—(Case VIII)



FIG 11—(Case X)

filled throughout the series The findings were significant of duodenal stasis which appeared to be due to partial obstruction of the duodenal-jejunal junction She was put to bed for two months on a high caloric bland diet, gained some weight but decided if she had to be operated on at any time, she did not want to waste any more time in bed

*Operation*—December 31, 1930, duodeno-jejunostomy for chronic duodenal obstruction The first portion of the duodenum just beyond the pylorus presented one firm peritoneal band running across its anterior surface Beyond this the duodenum was enlarged, this enlargement continuing to the duodeno-jejunal juncture The obstruction to the duodenum was caused by the superior mesentery vessels The right lower quadrant was explored No adhesions encountered In the left lower quadrant there were two adhesions of the omentum to the anterior abdominal wall Exploration of the duodenum and the obstruction to the duodenum noted

She got along until May, 1931, when she went to Bermuda On the way home she was seasick, and continued vomiting for two weeks Since that time she has had no spells of vomiting where it was necessary to go to bed, merely losing a meal occasionally Her weight has remained around 118 to 125, and her consumption of alcohol has continued entirely too much

Her medical attendant writes "The result seems to be excellent"

CASE IX—*Duodeno-jejunostomy only temporary benefit* Case report presenting comparison between surgical and medical treatment

A white single female twenty-one years of age admitted to private side of New York Hospital, January 22, 1928, because of heartburn and "lump" in epigastrium after meals for past three years

T and A twelve years ago D and C ten and eight years ago for dysmenorrhœa Eighteen months ago had repeated attacks of dizziness These lasted for one year, during which time gall-bladder drainage was done five to six times Until three years ago patient enjoyed relatively good health provided she was careful with her diet About that time onset of heartburn and heaviness in epigastrium, lassitude and vomiting, patient lost twenty pounds within a few months

Two and one-half years ago had influenza and since then has been troubled with mucous colitis During last six months epigastric pain has become marked even when on strict diet

Physical examination showed a rather thin adult female not acutely ill

Doctor Holland reports "Fluoroscopical examination showed the stomach quite normal except perhaps a little low in tone The duodenal bulb at first seemed to be somewhat defective but the defect was not characteristic of ulcer There was a very definite stasis at the angle between the second and third portions of the duodenum and with reverse peristalsis

January 23, 1928, under ethylene-oxygen-ether anæsthesia the abdomen was opened

Appendix was movable two and one-half inches in length, small calibre with a thickened wall Gall-bladder had some adhesions to omentum, freed The duodenum was fixed somewhat high, and bands from gall-bladder to duodenum and across it to colon were freed No ulcer felt in stomach or duodenum

The transverse colon was lifted and the duodenum beneath the transverse mesocolon was dilated It seemed wise to do a jejuno-jejunostomy

She reported in March of that year much improvement, had gained ten pounds In July her weight was 127, it was 115 when she first came She was experiencing some upper abdominal distress, more of a burning sensation, and her bowels had not been functioning properly and she had taken no exercise

Course uneventful following operation and discharged on eighteenth post-operative day

The last fluoroscopical examination made December 31, 1931, showed the anastomosis at this time The patient had complained of some slight distress one or two hours after meals without alkaline relief, of some slight regurgitation of tasteless material, but no actual vomiting Bowels fairly regular with agar

Last Fall she stated that she was feeling well except for occasional upsets

Doctor Holland states "It is interesting that her sister had been to see me two years previously, complaining of practically the same set of symptoms except that it had extended back for a long period She had never been really well since suffering an attack of influenza in 1916 She began to experience nausea and headaches occurring in attacks Some epigastric discomfort, occasionally quite severe There was some slight food and soda relief, but this was not marked Most of the trouble seemed to be an epigastric pressure occurring soon after eating It seemed to have no relation to the kind of food With the attacks of nausea there was some vertigo These attacks usually lasted from a week to ten days and very often followed the menstrual period of four or five days, but they did occur at other times as well She was intolerant of sea food, this caused violent cramps at times Aromatic foods, such as onions, she would taste for over twenty-four hours She had always been constipated but also had attacks of diarrhœa very often associated with the nausea and headache

"Fluoroscopical examination showed a normal stomach except for slight lack of

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tone, a normal duodenal bulb, a very definite stasis at the angle between the second and third portions of the duodenum with reverse peristalsis

"She was placed on a conservative plan, a soft, frequent-feeding diet, and much rest, she was given a Van Norden corset which incorporated a spring truss. She has reported from time to time improvement. She gained seven pounds the first two years of this treatment, but she had recurrences of her indigestion from time to time. In 1929, after returning from a European trip, which was probably more or less strenuous, she suffered a recurrence of the nausea, vertigo and epigastric distress. The fluoroscopic findings at this time were very much the same except that there was apparently more of a constriction than was formerly noticed in the second portion of the duodenum. This attack soon passed, however, and she has been fairly well since that time, but never entirely well. A course of abdominal pumping exercises seemed to help considerably.

"I heard directly from her last in 1930, but her sister has reported that she is feeling fairly well.

"It is interesting to compare these two cases as the patients are of the same habitus and approximately the same height. They live under the same physical and social conditions and are temperamentally very much alike.

"I am inclined to think that the one treated surgically has done a little better than the other one. Miss Ann is thankful that she had the operation performed and Miss Elizabeth is glad that she did not have an operation."

CASE X—Female, single, aged twenty-four. *Chief Complaints*—Cramps in upper abdomen, dizziness, nausea, weakness. *Past History*—Was a sickly baby and difficult to feed. At five became well nourished and continued healthy until about sixteen when she weighed 116 pounds, her maximum weight. Menstruation onset at thirteen, regular, little pain, moderate flow for five days.

Present symptoms began at twelve when she first began to have waves of nausea and occasional attacks of mild epigastric pain. Since then has fullness and bloating immediately after meals, especially after large meals. Is more comfortable if she lies down after eating. Has eructations of gas and rumbling for one hour after meals. Often has waves of nausea but has seldom vomited. Bowels always constipated.

In May, 1930, was operated upon for calcified mesenteric nodes which were located near the mid-line at the level of the fifth lumbar vertebra. The appendix was also removed.

In August, 1930, had an attack of severe epigastric pain with vomiting. Was taken to a hospital where intestinal obstruction was suspected. The attack subsided after three days and there has been no severe recurrence though she has had many mild attacks of pain but no vomiting. They occur once a week or oftener and last from five to thirty minutes. They may come on at any time of the day, never at night, most often in early forenoon. She has gradually lost weight, has become more easily fatigued and her mother says that she has gotten nervous and more difficult, especially in the past six months. She has had persistent acne which has resisted all treatment. Never had fever. *Physical Examination*—A slender girl with firm muscles. Weight, ninety-four pounds. Moderate acne on face and back. Upon pressure just above and to the right of the umbilicus there is tenderness and fine gurgling.

X-ray examination showed a vertical stomach, slightly hypertonic, normal size and good position. The pylorus was normal. The cap was normal in size and filled satisfactorily. The second portion of the duodenum made a wide swing to the right, producing the figure 4. It is fixed and lies on a level with the transverse process of the fifth lumbar segment both in the vertical and the prone positions. There was considerable stasis in the third portion of the duodenum with cradling. This was as marked in the prone position as in the vertical.

After four months of modified exercise, rest, diet, etc., patient was re-examined and no change was noted in the duodenum. Her weight was unchanged.

In this case the history of difficult feeding in infancy, and in adolescence having

indigestion is characteristic of congenital fixation of the duodenum. Dilatation of the third portion probably did not develop until after the operation for removal of calcified lymph-nodes and appendectomy.

January 12, 1933 Duodeno-jejunostomy. Divisions of adhesions. The first portion of the duodenum presented a high fixation and angulation due to a band of adhesions, apparently inflammatory, attaching it to the liver. These were freed and the angle of duodenum depressed. The transverse portion of duodenum showed marked distention. Adhesions of omentum to abdominal wall were freed.

*Result*—April. The patient is doing well and gaining weight.

CASE XI—Female, aged forty-three, single. Graduate nurse. Was unusually healthy and well nourished until the age of fifteen when she was sick for almost one year with stomachache and a low fever. Appendix was removed during this illness, but it was not acutely inflamed, and convalescence was prolonged. Eventually recovered and subsequently stood a three-year hospital training in nursing without a day's illness. At thirty she went to China and worked hard in a Mission Hospital for the next six years. At thirty-four she suffered with backache, fatigue and dysmenorrhœa. Disease of the right ovary was diagnosed and she was operated upon but the ovary was normal and nothing was done.

Patient dates her present illness from the age of thirty-five, when she began to have indigestion. Her bowels were normal until two years previous to that date when the movements began to be soft and since then she has usually two to four loose movements daily, mostly in the morning. She never had acute diarrhœa. At thirty-six an exploratory laparotomy was done which she reports revealed that her liver was shrunken and that something was wrong with her colon. Nothing was done. At thirty-nine a diagnosis of sprue was considered and she was treated for it. She has never been seriously anæmic.

Menstruation, onset at thirteen, regular, pain for the first two days. Flow always scanty. Duration four days. Weight. At twenty she weighed about 130, at thirty-five about 120. During the past five years has averaged 103. Present weight 95 pounds.

Patient has spent several months in various hospitals and her digestive tract has been X-rayed four times without finding any organic condition.

Within a few minutes after eating the patient feels "heavy and stiff in the pit of her stomach." This is often followed by nausea but she has vomited seldom. She soon feels gas in her stomach and begins to belch, frequently having severe, noisy attacks. Her upper abdomen becomes hard and distended. She frequently suffers with attacks of pain which she locates in her right hypochondrium and which is felt in the right side of her back and chest up to her neck. The pain is severe but never has required morphine. For seven years her tongue has been dry and it burns. She feels weak and gone and is afraid to eat because of the distress which follows. She sleeps well if she has no pain but often awakens at four or five A.M. with gas. She never has headache and has had no eruptions of the skin.

The patient has been studied exhaustively and carefully treated. Insulin has been given and food elimination diets have been followed without material improvement.

Her mental reactions were very interesting, her neurosis being deep and fixed. She was obsessed with ideas of serious organic disease, at times feeling that her liver was really shrunken. Again she believed that she must have some disease of her pancreas and at other times was convinced that she had contracted syphilis while in the Orient. She was well educated and intelligent but dressed like a child. A psychiatrist reported as follows: "She has a schizoid type of personality but certainly shows no evidence of having any schizoid psychotic reactions. She is an apprehensive, sensitive individual who, I believe, finding that she must no longer exert herself since she and her family are now in a comfortable position financially, has regressed into an infantile and rather fixed psychoneurotic reaction."

*Physical Examination*—Height, sixty-six inches. Weight, ninety-five pounds. Skin is deeply pigmented, giving the appearance of tanning from the sun. This was not

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increased in the flexures or about the eyes and the visible mucous membranes showed no pigmentation. Blood-pressure, 124-80. Heart, lungs, extremities and central nervous system all negative. The abdomen showed a three-inch median suprapubic scar and a six-inch upper right rectus scar. Moderate symmetrical distention, no visible peristalsis. Tenderness over the cæcum, the upper part of the long scar and over the splenic flexure. No mass or fluid. Solid viscera not palpable. Rectal and proctoscopic examinations negative.

Wassermann negative. Gastric contents showed no free hydrochloric acid, total acid, 22. Blood sugar, 102, uric acid, 4.8, non-protein nitrogen, 26, urea nitrogen, 15, icteric index, 4. Basal metabolic rate, +11. Fecal examination showed a moderate excess of mucus, no pus, blood, parasites or ova. No pathogenical bacteria.

X-ray examination showed a vertical stomach, medium size, normal tone, medium low, normal peristalsis. The duodenal cap was large but showed no defects. The second portion of the duodenum made a wide swing to the right and appeared to be fixed in position. The third portion was moderately dilated and contained barium throughout the examination. The stomach and duodenum were empty in two hours. The colon was negative. Subsequently a Rehfuess tube was passed into the duodenum and this showed a sharp angulation at the junction of the duodenum and the jejunum.

After careful study of the physical and psychical factors operation was decided upon.

December 1, 1932. Duodeno-jejunostomy for partial duodenal obstruction. Freeing of adhesions of transverse colon to old incision scar and freeing of adhesions of great omentum to sigmoid colon. Liberation of high fixation of duodenum. The duodenum was explored along its course and was found to be decidedly dilated in its third portion. The duodenum was dilated up to the point where the superior mesenteric vessels passed over it. They undoubtedly played an important part in causing the obstruction.

*Results*—Apparently improved though benefit uncertain.

CASE XII—Woman,\* sixty-two years of age, was admitted to the New York Hospital, October 23, 1928, because of attacks of vomiting which had occurred for two and one-half years. First attack was in May, 1926. At that time she vomited green mucous material, no blood. Vomiting continued for one week. She had another attack of vomiting four months later lasting for several days and another attack the following month which lasted only one day.

There followed a period during which she was well. She then had three similar attacks in November and December, 1927, and one in June, 1928. Each attack of vomiting was preceded by belching of gas and epigastric distress. Following the attacks she lost her appetite and felt exhausted for several weeks. Dr. Walter Niles, who saw her first in June, 1928, reports that June 14, 1928, her urine contained a large amount of sugar, as well as a marked reaction for acetone. There was no diacetic acid, there was a faint trace of albumin, and numerous hyaline and granular casts. On June 15 her blood sugar was 186 milligrams per 100 cubic centimetres of blood, June 16 her blood chemistry was as follows:

Urea nitrogen	18.0	milligrams per 100 cubic centimetres of blood
Non-protein nitrogen	35.6	milligrams per 100 cubic centimetres of blood
Uric acid	4.4	milligrams per 100 cubic centimetres of blood
Sugar	136.95	milligrams per 100 cubic centimetres of blood
Chlorides	468.75	milligrams per 100 cubic centimetres of blood
Creatinin	1.879	milligrams per 100 cubic centimetres of blood

June 17 and succeeding days there was no glycosuria.

Her next attack began on September 27, 1928. There was again a large amount of sugar in the urine with considerable acetone and diacetic acid. The sugar persisted for

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\* ANNALS OF SURGERY, July, 1929



four days, although the acid bodies disappeared in two days Her blood sugar on September 28, 1928, was 198

Fecal examinations made during the attacks showed large amounts of mucus and many undigested starch cells There were no other evidences of pancreatic insufficiency. Lost twenty-five pounds during two and one-half years

February 13, the abdomen was opened Adhesions were freed between the gall-bladder and the duodenum The colon was displaced downward and the duodenum mobilized The duodenum and head of pancreas were then lifted mesially like a trap-door The diverticulum was then identified closely opposed to the posterior aspect of the head of the pancreas It was collapsed but measured about two inches in diameter It was, of course, retroperitoneal Four or five large thin-walled veins lay on its surface These were ligated and divided The sac then readily dissected free Its wall was very thin, its neck two centimetres in diameter was situated at the lower part of the mesial



FIG 12—(Case XII) Large diverticulum of duodenum

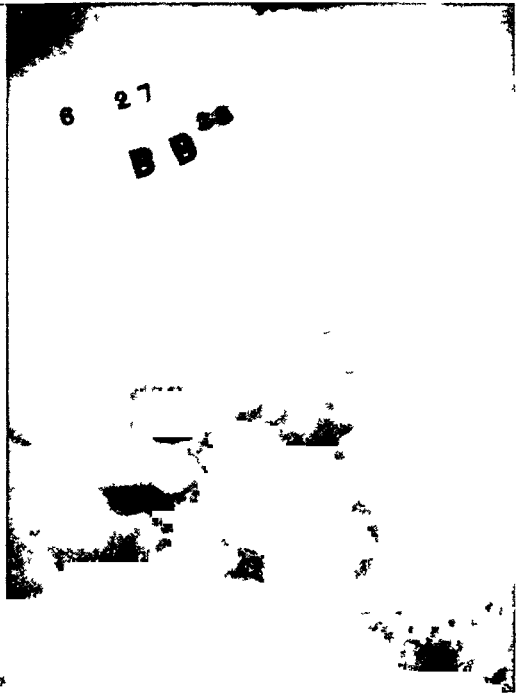


FIG 13—Same case showing retention in diverticulum

aspect of the descending duodenum The diverticulum was excised a short distance from the duodenum The orifice was repaired transversely with three rows of chromic gut Extreme care and thoroughness were necessary on account of the inaccessibility and the retroperitoneal position When the repair was completed it was felt that the lumen of the duodenum was so much encroached upon that obstruction might occur Therefore a posterior gastrojejunostomy was done The wound was closed without drainage

Post-operative course entirely smooth Patient discharged twenty-one days after operation She has had no further complaints, eats everything, general health good No sugar has been noted in the urine February 3, 1929, blood sugar 125 milligrams per 100 cubic centimetres of blood

This case is of interest, first, on account of the unusual situation of a large diverticulum (Figs 12 and 13) It lay posterior to the head of the pancreas Second, because of the peculiar symptoms, notably periodic attacks of vomiting with hyperglycæmia and glycosuria presumably due to pressure by the dilated diverticulum upon the pancreas or its duct Third, these disturbances were cured by operation

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DISCUSSION—DR WALTER L NILES remarked that these cases are often overlooked because the roentgenologists generally do not center very much attention on the small intestine beyond the duodenal bulb. The condition requires a certain amount of looking for.

Doctor Pool spoke of fluoroscopy as being important. It is very much more helpful than are X-ray films. One may take a great many films and not get a single satisfactory delineation of the terminal duodenum. The fluoroscopical examination is essential to the recognition of these cases.

About half of them have severe attacks of pain that are sometimes mistaken for more serious conditions, like cholecystitis. One young woman regarding whom Doctor Pool just reported was taken to a hospital with a suspicion of acute intestinal obstruction.

With congenital high fixation of the duodenum, the symptoms usually can be traced back to infancy and childhood. In these cases of chronic duodenal stasis the symptoms usually do not begin until later in life and sometimes not until quite late. He recently saw a woman of fifty-eight who had suffered from symptoms only during one year. She had a well-marked dilation of the duodenum with stasis. Probably the condition had been there, at least to a certain degree, for a good many years, but owing to exceptionally good health and muscular tone she had suffered no symptoms. Recently she had been subjected to unusual nervous strains, she had developed symptoms. It is very possible that with improvement in her nervous condition and her general physical condition she may again regain her compensation. At fifty-eight she is probably less likely to do so than if she were younger.

One other point regarding symptoms, and that is that they usually come on very quickly after meals, not infrequently while the patients are still eating. Sometimes they say they feel as if there is a lot of gas in the stomach and they wish they could belch it but they are unable to. A very pronounced and striking feature of all of these chronic cases is the psychic state. The psychoneurosis is profound in every one, and that, of course, complicates the picture a great deal and also makes decisions regarding the proper treatment more difficult. The whole picture is often attributed to a neurosis. They may have had several operations already and one naturally hesitates to advise another fearing the result of added psychic trauma. However, it should be done with the understanding that it is only the first step in their reconstruction and that subsequently they may, and probably will, demand psychic reeducation.

Doctor Pool spoke of a temporary functional disturbance of the duodenum. Doctor Niles was sure that it occurs. He had seen it demonstrated by the fluoroscope in quite a number of patients who had recently suffered illness or prolonged strain. A great many of those clear up, that is, they regain their compensation with the restoration of their nerve tone and general nutrition.

These patients generally present a picture of asthenia or hyposthenia. One thinks of them as enteroptotic types. We have come to feel more and more that the classification depends on the state of nutrition. For instance, in some of those operated on, when they have gained a good deal of weight they no longer present a picture of hyposthenia.

It is true that a great majority of these patients respond fairly well to medical treatment, which naturally consists in giving them a bland diet, small meals, often repeated, perhaps a period of rest in bed, certainly rest after meals, possibly hot applications, and sedative measures to relieve the irritability of the duodenum. There does remain, nevertheless, a group which, in his experience, has been about one-third, who are not relieved and require surgery.

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His personal experience was limited to six cases in which the results had been good invariably. He felt, therefore, that in properly selected cases operation for relief of this condition was one of the most satisfactory ones in surgery. It is obvious that these cases require very careful study and they need the combined interest of the surgeon, the internist and an intelligent roentgenologist.

DR GEORGE W CRILE (Cleveland, Ohio) said that they now have a series of 209 cases of duodenal stasis to report from the Cleveland Clinic. In all of these cases the diagnosis was made by the X-ray department. Out of that number, twenty-one have been subjected to exactly the same operation that Doctor Pool has so well described. Of this group, improvement was noted in ten cases, and in four cases there was no improvement. Seven cases could not be traced. This brief statement he made merely as a basis for discussion.

He had only two points to add to the experience reported by Doctor Pool and Doctor Niles. First, in their series, the patients who were not improved practically all belonged to the group who have what is called by the internist a constitutional inferiority complex. In these cases, the patients never have felt well. Such patients do not improve.

The second point he wished to make is that the fluoroscopical examination is the important thing. The reason why they had had such a large series of cases of duodenal stasis reported by the X-ray department is that a long time ago one of his first patients who had stasis of the duodenum and migraine showed such striking results. From that time on they subjected their cases of migraine to fluoroscopical examination to see whether or not it was associated with obstruction at the duodenum. It is extraordinarily striking, when one gets the right diagnosis, to see how promptly migraine is relieved by the simple operation described by Doctor Pool.

In their cases, one out of ten patients was subjected to operation. There were quite a few cases in which they got no valid improvement, most of them being among the cases of constitutional inferiority.

Finally he emphasized the point that it is well worth while as a routine measure in cases of migraine to make a fluoroscopical examination of the duodenum.

DR ALLEN O WHIPPLE (New York City) called attention to one phase of this subject which had not been sufficiently noted in the cases having duodenal stasis. In some thirty-two to thirty-four cases of duodenal stasis that have been studied largely as a result of Doctor Golden's interest in the fluoroscopy of the duodenum, they had found nine cases of this anomaly: the normal curve of the duodenum has shown a reversal in these nine cases, instead of the normal curve to the left, a curve to the right is given.

Two of these cases have been operated upon and have been observed carefully. The duodenum has been noted to pass behind the pylorus and the pancreas, emerging at a variable position as the duodenal jejunal junction. In these nine anomalies a marked stasis had been noted in five, two of these have been operated upon and both patients have given excellent results. In the two cases in which operation had to be done a duodeno-jejunostomy was done. A very definite angulation was found in the area posterior to the passage of the terminal duodenum behind the pancreas and the stomach. Unless these cases are carefully studied by fluoroscopy they will not all show in the X-ray by any means. In two of the cases, in fact, the films that were taken subsequently did not show on the film and it was only by subsequent studies that the outline of this reversed curve was noted both in fluoroscopy and in the film.

DR LEONARD FRFFMAN (Denver, Colo.) called attention to a congenital anomaly of the duodenum which has been the cause of the majority of instances of duodenal obstruction which he had seen, and which he had described in an article written in 1920 (*Surg, Gynec, and Obst*, p 454, May, 1920). The anomaly just spoken of by the previous speaker is of course of importance, but the one to which he now referred was different. It is a hangover from fetal life. He had encountered it a number of times.

The duodenum normally passes behind the mesentery of the transverse colon to the duodeno-jejunal angle, where it is hung up by the jejunal fold, so-called. In this particular anomaly, which will be found quite frequently if one looks for it, instead of passing immediately to the left the duodenum drops directly down toward the pelvis underneath the colon, forming a long pendulous loop with a mesentery of its own. It is thus loose and dangles within the abdominal cavity, but always it is fastened up to the normal position of the jejunal fold, at the duodeno-jejunal angle, near the root of the mesentery of the transverse colon. Being hung up in this way, like a soft rubber tube over a nail, it becomes kinked and, in addition, twisted to a certain extent upon its axis, thus adding to the obstruction.

There are two ways of remedying this obstruction surgically. One is by duodeno-jejunostomy, so well emphasized by Doctor Pool. The other is to divide the adhesions constituting the jejunal fold, at the duodeno-jejunal junction, which is usually not difficult unless the patient is too fat. This often leaves a large, raw surface which can readily be covered with peritoneum. Such an operation is devoid of danger if one is at all careful of the surrounding structures. It answers the purpose just as well as an entero-anastomosis and may be preferable because it not only relieves the obstruction by straightening out the duodeno-jejunal angle, but it does this without opening the bowel or leaving any excluded portions to give trouble later on.

DR EUGENE H. POOL (New York City) said of course these cases have to be very carefully selected. Cases of constitutional deficiencies should not be operated upon for this or anything else except in emergencies.

Duodeno-jejunostomy for an obstruction higher than the transverse portion of duodenum is, of course, contra-indicated.

The anastomosis will not be effective if the obstruction is in the second portion of the duodenum. Duval has devised an operation which he calls a gastro-pyloro-duodeno-jejunostomy, to drain the upper part of the duodenum, pylorus and stomach. It has been done by Duval and his associates about a hundred times. It seems a bizarre procedure but is worth bearing in mind if one encounters a sharp obstruction in the lower part of the descending portion of the duodenum which, very occasionally, occurs as a result of a low duodenal ulcer. He had seen one such case.

# THE TRAGEDY OF GASTRIC CARCINOMA

A STUDY OF 200 SURGICAL CASES

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IN THE ten-year period extending from 1922 through 1931, 758 patients were treated in the New Orleans Charity Hospital for carcinoma of the stomach, with a hospital mortality of 245, or 32.3 per cent. Nearly three-quarters of these patients, 533, or 70.3 per cent, were not treated surgically, chiefly because they were far beyond the reach of surgery, and 148 of them died in the hospital, a mortality of 27.7 per cent. Of the 275 patients who were operated on, ninety-seven died in the hospital, a mortality of 43 per cent. That 15 per cent difference in the death rates could be used by those persons, professional and lay alike, who are not surgically minded, as an argument against the performance of surgery for this disease, but it would not be a fair argument. I do not know how many of the 128 men and women who left the hospital alive after operation are still alive, but I suspect it is only a negligible number, for only a negligible number had the sort of surgery from which any hope of cure could ever be expected. But I do know that if the diagnosis of carcinoma of the stomach were correct, as the hospital mortality of 27.7 per cent proved it to be in 148 cases, at least, then none of the 385 men and women who left the hospital without surgery can possibly be alive now. They did not die within the walls of this century-old institution that has sheltered and succored so many in their last hours, but without exception as they went forth from its doors, in no better condition than when they entered them, they carried the candle of death in their hands and on their faces the seal of death was set. Surgery may achieve little in this disease, but without surgery there can be no salvation.

Of gastric carcinoma there is little new to write, but that does not mean that of gastric carcinoma much should not be written. Only by ceaseless study, only by unremitting effort, can we hope to increase our salvage—it is literally a saving from shipwreck—in this most tragic of all diseases. We make no apology, therefore, for presenting to this Society an analysis of carcinoma of the stomach which is based on the last 200 surgical cases done at Charity Hospital. We have studied these cases clinically rather than statistically, in an endeavor to find out, so far as we could from the records, why ninety of the patients died within the hospital, and why, of the 110 who went out alive, only sixteen could possibly hope to be permanently cured.

From every standpoint this is a perfectly fair analysis. Racially, the

incidence and the mortality are strikingly alike 101 white patients with forty-six deaths, ninety-nine Negro patients with forty-four deaths While the percentage of males, 172, or 86 per cent, is rather higher than is usually reported, the predominance of the disease in men is unquestioned Although more than three-quarters of the operations were done by ten surgeons the 200 cases were distributed among thirty-one surgeons, and that again, is as it should be in such a study, for it is as it would be in practice The argument is perfectly sound that gastric surgery should be done only by surgeons trained and experienced in that particular work, but actually we all know that gastric surgery, and every other variety of surgery, for that matter, is most often done by surgeons of average experience or small experience or no experience so long as patients are willing to be operated on by surgeons of all grades of competence and incompetence, just so long must the results of all surgeons be figured in the statistics Finally, this is carcinoma of the stomach as it is really seen This is carcinoma of the stomach as it most often reveals itself to the surgeon not in a selected group of patients with a relatively high percentage of operability and a correspondingly brilliant percentage of cures, but in the patients who seek us and our aid just before the curtain falls Because it is the material of a general hospital, it is material that represents the general population, and so it is the true tragedy of cancer

One of the first points that impressed us as we surveyed these cases was the age of the patients The age limits were twenty-one to seventy-nine with the highest incidence 38.5 per cent, in the sixth decade, and the next highest, 25.5 per cent, in the fifth That is what we have been taught and what we would expect But it is highly significant that three patients were under thirty-years, the youngest being twenty-one, and that fourteen others were under forty, which means that 8.5 per cent were well below even the lowest limit usually set as the boundary of the cancer age Alvarez<sup>1</sup> has made the statement that one out of every nine persons with carcinoma of the stomach is under forty-five, but in this series approximately one out of every nine was under forty Is not the overlooking of just such facts as these one of the causes of the terrific mortality we are attempting to analyze? It is quite true that the younger the patient with gastric symptoms the less likely is his disease to be malignant, but it is also true that in medicine, no less than in life, the proportion of probable error is always far higher than is realized, and the possibility of cancer therefore, must ever be borne in mind, regardless of age limits, regardless of the law of averages Particularly should the possibility of cancer be borne in mind before the facile diagnosis of benign disease is made and the patient is treated by non-surgical measures

We next investigated these patients from the standpoint of the duration of their symptoms, and we found that seventeen had been aware of their illness for less than a month and 108 for less than six months, the mortality for the whole group being 47.5 per cent To a certain extent, we presume, the stories can be discounted Perhaps they were told inaccurately, perhaps

they were recorded carelessly, perhaps the symptoms had actually lasted much longer but were realized only for that length of time because sensibility was really decreased and the threshold of pain was really increased. The realization of the symptoms, however, is the patient's reason for medical consultation, and the fact stands that in one half of the patients in the series that realization was of very short duration, although the inherent gravity of the disease, the moods it had already made, are indubitably proved by the death rate. But at the other extreme, twenty-one of the patients, nearly 10 per cent, told a story of symptoms which had lasted from five to thirty years. Some of these people had sought no medical advice until they sought hospital admission, and the responsibility for that delay does not lie at the door of the medical profession, but many of them had been treated medically, on vague diagnoses or none at all, for varying periods of time before their admission, and in those cases the responsibility for the delay is clear and plain. Moreover, aside from that consideration, how is one to reconcile the facts of a disease in which the duration of symptoms may be anywhere from two weeks to thirty years?

A statistical analysis of symptoms is in our opinion never satisfactory, and therefore we have not attempted it, but we arrive at the definite impression of certain symptom groups as we review these histories. We note a group in which the symptoms are ushered in abruptly, frequently by a dietary indiscretion, from which, perhaps, there is never full digestive recovery. We note a group in which the symptoms date from a previous, apparently unrelated illness, from which recovery is slow and the weakness and malaise of which tend to linger. One such patient, for instance, had had a full-term delivery a month before she was hospitalized for the gastric carcinoma from which she died, her symptoms had been masked by the events of her gestation and did not manifest themselves independently until after her delivery.

We note a group in which the first symptom, if we can trust the story is hæmatemesis, and another group in which vomiting of the coffee-grounds type is the outstanding feature. We note a group, a rather large group, in which the symptoms are vague and undetermined. These individuals have ceased to enjoy life. They suffer from malaise, they lack strength, they have lost weight, they do not care for their food, they prefer not to eat it, they are constipated when they have never been constipated before, their whole mental and physical outlook has been changed. Digestive symptoms are a late development, sometimes they manifest themselves only as the end draws near. A surprising number of patients in this group entered the hospital actually unaware that their illness had anything to do with the gastrointestinal tract.

Then there is the group in which, on a basis of previously sound and previously robust health digestive symptoms are superimposed. At first there is epigastric discomfort which is unrelated to food then there is definite pain which is increased by food. At first there is merely nausea or the



regurgitation of mucus, then there is vomiting, and much later there is the vomiting of food which has been eaten hours or even days before. In some of the patients in this group the diagnosis of gall-bladder disease was certainly warranted, at least in the beginning, for their first indigestion was definitely qualitative. If they ate certain kinds of food they knew they would suffer for it, and so, very sensibly, they regulated their diet by the trial and error method, until eventually they found out what they could eat safely, even though sometimes it amounted to little more than liquids.

All of these patients were proved by operation, and many of them by autopsy also, to be suffering from carcinoma of the stomach, and yet in the 200 cases there are almost a dozen different clinical syndromes. Their symptoms, considered individually, could mean anything or nothing, but the single symptom is never comparable in importance to the symptom group, or to the person in whom it arises. There is not a case in the series in which, in the light of what happened later, the diagnosis could not have been made if the patient had consulted the physician promptly and if the physician had considered his patient as an individual suffering from an individual illness instead of endeavoring to thrust him and his symptoms into a ready-made diagnostic groove. If we emerged from this study with no other idea, we did gather from it that the only safe mode of medical practice is to consider every patient as an exception to the rule, on the ground, as Gordon<sup>8</sup> puts it, that while averages are quite true of the population at large, they are entirely untrue of the patient as an individual. Granted that in some cases early symptoms seem to be lacking, in the majority of cases the trail is there, the physician simply fails to find it, or having found it, fails to follow it, because it is not a broad and straight highway. We believe, therefore, that from the standpoint of diagnosis the best aid is a carefully taken history, a history which is secured only by patient and persistent questioning, and which takes note, as Moynihan<sup>14</sup> says, of the earliest departure from health of which the individual has knowledge rather than of the symptom complex which now occupies his attention.

One group of patients we have purposely reserved for discussion until this point, for their introduction is always the signal for the bursting of a storm. We read these histories with particular care. We charged ourselves sternly against bias and preconceptions. In our endeavor not to be prejudiced we literally leaned over backward, and we discarded many cases which other observers, we feel sure, would have included. But with all these precautions and all these exceptions we still found that 25 per cent of these patients gave a perfectly typical, perfectly definite story of gastric ulcer. That they all had ulcers is, of course, unthinkable, and we do not claim it, but that they told ulcer histories we do contend, and that some twenty-nine of the fifty, at least, were treated for ulcers their records clearly prove.

We set up specific criteria for our classification. We required symptoms of more or less long-standing, in twenty-one cases they had lasted two years or more, and in fifteen cases they had lasted more than five, which is well

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beyond the period untreated cancer patients could be expected to live. We required that the epigastric discomfort definitely be related to food, and that it be relieved by the taking of food and alkalis and by the institution and maintenance of a bland diet. And we required also intervals of remission, for in such remissions, in our opinion, lies the chief difference between the ulcer history that is provoked by an ulcer and the ulcer history that betokens cancer.

We admit that we concerned ourselves purely with clinical data, 'for we share Moynihan's<sup>14</sup> opinion of the value of that sort of evidence when it is rightly acquired and honestly assessed.' We believe, also, that the clinical aspect is far more important than the pathological, and it therefore does not change our opinion to find the surgeons in the operating room and the pathologists in the laboratory and in the autopsy room reporting that only thirteen cases of the 200 manifest the association of ulcer and cancer. We agree with Moynihan again, that at the operating table and in the post-mortem room the evidence of the ulcer is frequently obliterated, and that "not all the palimpsests can be deciphered."

The pathologists question the superimposition of carcinoma upon ulcer or they deny the transition from ulcer to carcinoma, whichever way you may choose to regard it, and academically their position is probably unassailable though personally we cannot comprehend why chronic irritation within the stomach should not have precisely the same effect that chronic irritation anywhere else would have. That, however, is not the point at issue, any more than the point at issue is the one over which controversy so often and so mistakenly rages, the percentage of cases in which carcinoma is associated with ulcer or is superimposed upon it or develops from it. The point at issue, and it is a purely clinical point, is that some patients with a definite ulcer history, with a radiological diagnosis of ulcer, with laboratory findings typical of ulcer, with all the clinical and scientific evidence in favor of ulcer, prove the utter unreliability and worthlessness of that evidence by dying of cancer. When or where or how the malignancy originated may interest the pathologist, but it is not of the smallest interest to the clinician who made the mistake and to the patient who paid with his life for the error. Fourteen of the twenty-nine patients in this group who were treated medically for a supposed ulcer died in the hospital, and in not a single one of the remaining cases could resection be done, which means that the other fifteen patients were just as clearly doomed to death. This series, and every similar reported series, makes one fact very clear—that the differentiation between gastric ulcer and gastric cancer is impossible by any known means short of surgical exploration—and it is not always easy or always possible then—and that one of the chief factors in the mortality of carcinoma of the stomach is the medical treatment of supposed peptic ulcer, particularly when, as so often happens, the medical treatment is temporarily successful.

Almost the only thing common to the majority of these patients was a marked loss of weight, a loss that is always more pronounced in gastric

carcinoma than in any other disease which gives rise to gastric symptoms. Only twenty-six patients were described as well-nourished, though an appearance of health is, of course, not incompatible with a wide dissemination of the disease. One hundred fifty-nine patients, or 79.5 per cent, had suffered a loss of weight ranging from ten or fifteen pounds in many patients, to fifty pounds in two patients, both of whom died, and seventy-five pounds in one who, surprisingly enough, left the hospital alive. The terms emaciation and dehydration appear on these charts with monotonous frequency, and it is only too easy to picture from them the ashen-faced, sunken-eyed, pinch-nosed old men who represent the disease as it is usually seen in hospitals and as it should never be exhibited to students and to young physicians, except as a terrible warning.

Eight of the patients were jaundiced, of whom three died, for jaundice is a late sign and an ominous one. In eighty-five patients, thirty-eight of whom died, a definite mass could be made out. In only five cases, three of them fatalities, was Virchow's node palpable, probably, we surmise, because it was not looked for oftener. In not a single case was metastasis to the rectal shelf noted pre-operatively, and it is mentioned in only a few of the operative records. This metastasis, which in our opinion is often the deciding factor in the debate over operability, is for some reason mentioned only rarely in the literature, and it is not surprising that both histories and operative records should have ignored it also.

It required no particular degree of astuteness to make the diagnosis in most of these cases, as happens only too often in malignant disease, it was so clear-cut that it carried with it the inevitable corollary of the improbability of cure. But the usual means of confirmation were naturally employed. The X-ray, the most certain of all diagnostic aids, was employed in 165 cases, being omitted only when operation had to be done without delay for hæmorrhage and acute obstruction, or when the diagnosis was so evident and the indication for some sort of palliative procedure was so plain that the patient was not put to the added discomfort and inconvenience of a barium meal. In six cases it was negative, in seven it was incorrect—it is curious that only once was the diagnosis of gastric ulcer suggested—and in 92 per cent it was positive.

We pause at this point to emphasize the limitations and the actual dangers of the X-ray when it is used as anything more than a confirmation of clinical suspicion. Naturally, the more advanced is the disease, the higher is the percentage of correct diagnoses and the less necessary is the aid of the radiologist—we write, as did Alvarez,<sup>2</sup> not in malice but in humility. But it does not follow that the radiologist is at fault because he does not detect the early case. The tumor may be so located that it cannot be seen. It may be so small that it is not demonstrable. There may be no infiltration of the muscular coat, and the evidence of the arrested peristaltic wave which is generally regarded as the earliest radiological sign, may be entirely lacking in repeated examinations in all positions. The fact that X-ray study is negative is no

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proof against the existence of a neoplasm, it was negative, as we have already pointed out, in six instances in this series

The chief objection to the X-ray as a method of diagnosis is the clinician's increasing habit of letting it do his thinking for him, and of guiding his procedure by what it does and does not reveal. We question whether a decision as to operability should ever be made on the basis of the X-ray findings alone. They are as Moore<sup>13</sup> points out, of great value in determining the location of the tumor, of doubtful value in demonstrating fixation, and practically never of value in revealing metastases, upon the existence of which depends the decision as to whether and how operation should be done. As a matter of fact, the X-ray should always be used with safeguards and with reservations. Its eye, as Golob<sup>7</sup> well puts it, is never analytical, and the tendency of physicians generally to let it halt further investigation when the report is negative makes one wonder, on occasions, whether it might not be well to invoke it as a last resort rather than as a first aid.

Upon other laboratory investigations we set varying values. The presence of occult blood, either in the gastric contents or in the stools, is a definite indication of ulceration, but is of no value in demonstrating where the ulceration is located or of what variety it is. We agree with those observers who claim that gastric analysis is of small help in the early case, in which it is most needed, though it is usually perfectly characteristic in the late case, in which the diagnosis needs only confirmation, if that. It was done in 104 cases in this series, ninety-seven of which exhibited a hypoacidity with a hypochlorhydria or an achlorhydria, but those findings are typical of many other diseases, while a certain school holds, perhaps, with reason that achylia is an antecedent of gastric carcinoma rather than a consequence.

The anæmia of carcinoma of the stomach is an established fact and it is granted that it may be of so profound a degree as to mimic pernicious anæmia, Moynihan<sup>14</sup> suggests that in doubtful cases it be differentiated from it by the therapeutic test of the Murphy-Minot diet, to which primary anæmia responds brilliantly but secondary anæmia poorly if at all. In this series, in some 75 per cent of the patients, the anæmia was more or less marked, sometimes running as low as 1,200,000 red cells and 30 per cent hæmoglobin, even without the factor of hæmorrhage to explain it, but we found, as did other observers, no constant relation between the degree of anæmia and the stage of operability.

Leucocytosis, never to a very marked degree we found in some 15 per cent of the cases not a surprising finding in view of the infection frequently associated with advanced carcinoma. It is rather surprising, however, to find some 20 per cent of the patients whose blood was studied suffering from a leucopenia sometimes as low as 2,500. Are we to interpret this fall in the white cells as evidence of the degree to which this disease reduces the resistance of the host? The percentage of renal disease which naturally has nothing to do with the malignant process as shown by a reduced phenolsul-

phosphthalein output and an increased retention of non-protein nitrogen, was about what would be expected in a group of patients within these age limits

Looking at these histories in retrospect, we gather from them that there is no symptom that is always present, and likewise none that may not sometimes be absent. We gather from them that diagnostic difficulties increase in exact proportion to the promptness with which patients seek medical aid, for the early symptoms, while they are important in the aggregate and eventually, are insignificant and misleading individually and presently. We gather that digestive distress, which would seem logically to be the cardinal symptom of a disease located in the stomach, may be entirely absent, and if present, may be no more characteristic of carcinoma than of any other disease with gastric manifestations.

Since there is clearly no specific laboratory test, chemical, serological or microscopical, upon which reliance can be placed, and since the very excellence of modern laboratory methods introduces the danger of overlooking even more valuable subjective and objective evidence, we are driven back to purely clinical considerations. We gather from these histories that there is just one plan of diagnosis that is even reasonably safe to regard as cancer any indigestion, with or without symptoms, which appears after middle life, acutely or insidiously, in a previously well person, to regard as cancer any acute digestive disturbances within this period which are superimposed upon chronic digestive disturbances and which do not respond promptly and permanently to routine measures which have heretofore been successful, to regard as cancer, or as highly suspicious of it, such vague general symptoms as fatigue, malaise, mental indifference, insomnia and loss of weight, even though associated gastric disturbances are entirely lacking, to continue to regard as cancer any one of these clinical syndromes until it is proved beyond shadow of doubt not to be cancer, to make the diagnosis with the aid of auxiliary methods but never on the basis of them, and, finally and most important, to resort without delay to exploratory laparotomy if the diagnosis cannot be made positively without it.

Even when these rules are sedulously obeyed, there will still be errors of diagnosis, but perhaps there will be fewer tragedies due to delay. Why patients do not consult physicians with more promptness is an unsolved mystery. The group which fears cancer too much or surgery too much to investigate symptoms that cry aloud for investigation is beyond comprehension but it must be reckoned with. Another group consists of the patients who, having suffered from digestive distress over a long period of time, do not recognize the significant change in the character of their symptoms. There is the group we have already spoken of, who are either unusually stoical or have an unusually high threshold of pain and so who are honestly unaware of their symptoms until their disease is far advanced. Finally, as McVicar and Daly point out, the typical carcinoma age is the age in which certain discomforts due to involuntary degeneration, focal infection and similar causes are to be expected, and are ignored by the breadwinner of the

family who must maintain his place in the competitive struggle, a reason that is even more tragically true in this day than it was when the lines were first written

But the patient is not always to blame. In this particular series there were very few cases in which, at least when hospital admission was sought, the diagnosis was not evident with ghastly clarity, and the delay until operation was never very great. It was sometimes longer than it should have been because the mechanism of hospital consultations sometimes moves slowly, but there were few instances in which it was not relatively prompt. But before admission, as we have already pointed out, at least some physicians delayed and temporized, and their number, had the records been written more carefully, would undoubtedly be greatly increased, for in every reported series the same errors have been made. In the series reported by Saltzstein and Sandweiss,<sup>17</sup> for instance, some patients had had medical treatment for an average of eight and one-half months. Oughterson<sup>15</sup> mentions one man who had been seen by twelve physicians over a period of two years. Surely if the medical man, or the surgeon, for that matter, cannot put an exact name to a disease, he can at least carry always in mind the thought of malignancy, and he can refrain from any advice and any treatment that does not involve surgical exploration. Cole<sup>5</sup> mentions, with a very high degree of scorn, the routine wording of the X-ray reports of a decade or two ago: "This patient has a filling defect, the exact nature of which can be determined only by surgical exploration," but his scorn is out of place, it would profit a great many patients today if their X-ray reports carried the same explicit statement and the same implied warning, and if medical men generally paid heed to the admonition.

Of the 758 patients admitted to the hospital during the ten-year period we took as the starting point for our investigation, a few refused surgery, but the majority of the 533 medical cases were medical because they were obviously beyond the reach of surgery, 27.7 per cent of them proved that promptly and conclusively by their deaths. During that period, in other words, less than 30 per cent of the patients with carcinoma of the stomach could be considered as candidates for surgery of any sort. Now, taking as typical the 200 cases we studied in detail, it is apparent that the majority of those who were operated on were considered as surgical risks of any sort only by the most generous application of surgical indications. The mortality of ninety, or 45 per cent, proves that very clearly, as does the division of the cases: gastrectomy, the only procedure which offers the faintest possibility of cure, could be done in only thirty-five cases, 17.5 per cent of the series, while in fifty-six cases, or 28 per cent, the abdomen was closed as soon as it was opened, for any sort of surgery was hopeless.

To consider the figures in detail, 17.5 per cent of the patients were submitted to gastrectomy, with an immediate mortality of 51.4 per cent, as compared with 43.75 per cent in the series reported by St. John,<sup>19</sup> 52.6 per cent in the series reported by Oughterson,<sup>15</sup> and 40.3 per cent and 64 per

cent in two series collected by Saltzstein and Sandweiss<sup>16</sup> On Balfour's<sup>3</sup> report of a 10 per cent mortality in 200 cases we shall comment later Eighty-three patients, or 41.5 per cent, were submitted to gastroenterostomy, and the mortality was 43.6 per cent, as compared with 26.6 per cent (exploration is probably included) in St John's series, 28.3 per cent in Oughterson's series, and 66 per cent in Saltzstein and Sandweiss'<sup>17</sup> series Fifty-six patients were submitted to exploration, and the mortality was 30.4 per cent, as compared with 21.7 per cent in Oughterson's series, and 58.6 per cent in Saltzstein and Sandweiss' series Twenty-one patients, or 10.5 per cent, were submitted to gastrostomy or jejunostomy, and the mortality of nearly 81 per cent needs neither comparison nor explanation, for all of the operations were done upon patients who were either frankly moribund or were in the last stages of their disease, but for whom some attempt at relief seemed imperative

This is an appalling record from every standpoint, but our own figures and the figures of other series reported on the same basis bear a striking similarity We would emphasize again that the reports from such institutions as The Mayo Clinic and by such surgeons as Balfour are in no way representative of the general run of material or of the general results of surgery They represent an ideal to be striven for, but we stultify ourselves if we say that it is likely to be soon attained A search of the literature shows that statistics compiled from and based on the general population and on the population of general hospitals are invariably tragic figures Resection, speaking categorically, is seldom possible in more than 8 per cent of all cases, and the prospect of cure is immediately cut in half by an operative mortality of at least 50 per cent That means that ninety-six out of every 100 patients are today doomed to death from the outset of their disease Furthermore, while surgical exploration for purposes of inquiry, as Moynihan very correctly says, has scarcely any mortality in this aseptic era, surgical exploration for purposes of inquiry at the first exhibition of symptoms and surgical exploration near the end of an illness, in the vain hope that something can be done for obviously hopeless disease, are two very different considerations, and the mortality of the latter procedure is inevitably high

Let us grant freely that technical errors and bad judgment and, to be quite frank, a certain amount of inept surgery, account for part of this fearful mortality But it does not account for it all, and the question immediately arises as to what are the criteria for surgery under these circumstances, and what is the surgical ethic Clinically, the decision for or against operation is made on the general condition of the patient, the estimated extent of his local disease and the probable existence of metastases Had those considerations been strictly weighed in this series, many of the patients would certainly not have been operated on, they were poor surgical risks, their disease was of long standing and the presence of metastases could have been assumed But the physician who advises against surgery and the surgeon who withholds surgery take upon themselves a very grave responsibility

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There is always the chance that the clinical evidence is wrong, always the chance, even in the most hopeless-seeming cases, that something can be done for comfort, even if nothing can be done for cure

What should be done when the abdomen is opened is another matter. Too often nothing is possible, though, if the patient survives the operation, a surprising and inexplicable degree of temporary clinical improvement is often noted. Gastroenterostomy is rarely indicated unless actual obstruction exists or unless the location of the tumor makes it clear that it is likely shortly to occur. W. J. Mayo speaks of "the hopeless gastroenterostomy that enables the patient to live longer and suffer more," but that is not altogether fair, every surgeon can recall wisely selected patients whose remaining days were made more comfortable by this procedure. Gastrostomy and jejunostomy are frankly operations of despair, the results are always bad and the mortality is always high, they are done upon frankly dying patients, but at that, they have their field. Gastrectomy is the ideal operation when it is possible, for it is the one form of surgery from which any permanent results can be expected, but it is only rarely possible. It is frequently a wise procedure, however, even when the circumstances are not favorable, for the mortality is often no higher than the mortality of gastroenterostomy, indeed is frequently lower, and if it does succeed it gives a degree of comfort and well-being, temporary though it be, that more than compensates for the immediate risk.

Ninety of these 200 patients died, and in at least half of those ninety cases the fatality was frankly attributable to the operation, for it was precipitated by shock, by hæmorrhage, by peritonitis, or by other definitely surgical complications. We do not doubt, as we have said, that in some cases, at least, the surgeon was at fault, though we would emphasize again that very few of these patients were good surgical risks, and that the majority of them were very poor risks, it took courage to operate on them at all. But all of that is beside the point. As far as we are concerned, the mortality, terrifying though it be, is justified, for the patients who died were clearly doomed, with or without operation.

The surgeon has every reason to reproach himself if for the sake of his own fair record, he withholds from doomed men and women their frail chance of life. He need not reproach himself for his surgical mortality when he gives them that chance. Without surgery, the death rate in carcinoma of the stomach is 100 per cent, and it cannot be too often emphasized that every patient saved from death by it is a patient who otherwise would have died. There is an old Arabian proverb to the effect that he is no physician who has not slain many patients, and the surgeon who operates for carcinoma of the stomach must remember that often, just as he must remember, too, what Royster says, that where there is no surgical vision the patients perish. The duration of life after operation is only one aspect of the question, another consideration, and quite as important a consideration, is the freedom from pain and suffering which surgery brings to pass and which cannot be



reckoned in statistical tables For the patient with carcinoma of the stomach is, as the inscription over the cancer wing of the Middlesex Hospital reads, truly the responsibility of the physician "until he is relieved by Art or released by Death," and the surgeon, as Cheever<sup>4</sup> says, is truly the agent of relief whichever way relief may come

SUMMARY —(1) The appalling mortality of carcinoma of the stomach warrants a further consideration of the disease

(2) A clinical analysis is made of 200 consecutive surgical cases from the records of Charity Hospital in New Orleans

(3) From the standpoint of diagnosis these cases are studied in regard to age, duration of symptoms, symptom groups and laboratory findings

(4) The relationship of gastric cancer to gastric ulcer is considered in its clinical aspects

(5) The criteria of safe diagnosis are set down

(6) The various operative procedures employed are considered from the standpoint of mortality

(7) The conclusion is arrived at that surgery is justified in carcinoma of the stomach, even in apparently hopeless cases, because of the possibilities of temporary relief if not of permanent cure

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DISCUSSION —DR FRANK H LAHEY (Boston, Massachusetts) said it appeared to be very difficult to arrive at definite conclusions regarding the question of malignancy in gastric ulcer. They have had in their Clinic 172 gastric ulcer patients. Of these, ninety-two have been accurately followed after non-operative treatment. The true test of pathological diagnoses is what happens to the patients in years to come. Of all who were diagnosed ulcer not operated upon and carefully followed up, only one developed carcinoma. The question of what percentage will develop carcinoma and what percentage will not depends to a great extent upon how carefully they are studied and how accurately they are segregated into ulcer and cancer in these diagnostic examinations.

One can say that the danger of malignant degeneration in lesions which simulate or are ulcers is as follows: 100 per cent, in their experience, of the lesions of the greater curvature have proven malignant. The next lesions which tend most to become malignant are the pre-pyloric lesions, and the closer they are to the pylorus on the gastric side the more often they are malignant. Next in danger of malignancy are the posterior wall eroding ulcers, and the least liable to be malignant are the alcove lesions on the lesser curvature.

His experience has been that exploration for the demonstration of malignancy in gastric ulcers was disappointing. When he found on visualization of the lesion that he had metastasis in the liver with white pearly plaques in the peritoneum, and firm glands in the mesentery, those lesions can usually be diagnosed as malignant before operation.

On the other hand, when one exposes the hard, calloused chronic gastric ulcers with none of these distinguishing features, then one just cannot say whether it is malignant or not and the operation no longer becomes an exploration. One hesitates to close this patient with a suspected malignancy, and resection is done.

He has therefore sought additional help in the demonstration of possible malignancy in the border-line gastric ulcers. He thinks the plan which most of the gastroenterologists now practice is a very valuable one. It is particularly applicable to ulcers on the lesser curvature and the pre-pyloric ulcers. These patients are put to bed on a careful medical regime. They are fluoroscoped every two or three days. As long as the lesions tend to diminish in size, occult blood disappears from the stool and the symptoms are showing improvement these patients are not operated upon.

If, however, he wishes to safely segregate the carcinomas from the non-carcinomas, the final criterion is that the defect, under this plan of management, must ultimately disappear and so must all the symptoms and blood in the stools. If these criteria are fulfilled, these lesions will not prove malignant, in his experience. If they do not disappear, or if they disappear all but a teat-like projection, they must be submitted to the radical procedure of subtotal gastrectomy, since under these conditions they will prove to

be either intractable ulcers or malignancy, and there is no way of telling then which is which

DR J SHELTON HORSLEY (Richmond, Virginia) said that according to a recent census, it is estimated that there are over 120,000 deaths from cancer each year. That has almost doubled within the last fifteen or sixteen years. Of this number, approximately one-fourth are cancer of the stomach. It seems, then, that with an increasing morbidity and mortality like this one cannot emphasize the situation too much.

It is true as Doctor Maes says, that these cases clinically are sub-divided into those that have had symptoms for some time and those that have not. He possibly underrated the importance of the laboratory diagnosis. By that Doctor Horsley did not mean necessarily blood counts or even gastric analysis, although they help. A carefully taken X-ray examination by one competent to do it is extremely valuable. If there is a gastric lesion it puts the responsibility upon the practicing physician and upon the surgeon at the same time.

As to when these gastric ulcers become cancerous, it is difficult to tell. Holmes, for instance, of the Massachusetts General Hospital, has emphasized the fact that even when one has the ulcer in the hand one cannot always tell whether it is malignant or not. The ultimate results depend largely upon an early operation, and yet there are some late cases, possibly of the colloid type, in which a late operation gives satisfactory results.

He recalled the case of a woman who had felt a palpable tumor for a year before she was operated upon. The lesion was quite extensive. Partial gastrectomy according to a modification of Billroth I was done. She made a satisfactory recovery and died three years later with metastasis of the chest. There was no clinical symptom of local recurrence, but no necropsy was done.

One other point is that gastroenterostomy holds, if any, a very limited field in cancer of the stomach. As Doctor Maes has shown, the mortality is great. In cases in which the lesion is near the pyloric end of the stomach, even if there are comparatively mild metastases in the liver, partial gastrectomy carried out probably with a local anaesthesia and with careful preliminary preparation, particularly washing out the stomach and giving one-half of 1 per cent hydrochloric acid for two or three days, will not give a very great mortality rate. The patient will have far more comfort by removing an obstructing septic fungating lesion at the pyloric end of the stomach than he would after a gastroenterostomy.

DR ROSCOE R GRAHAM (Toronto, Ontario) said that in the management of a gastric ulcer one is not so much interested in whether the ulcer will become malignant, as in determining whether or not it is now malignant. In a recent series of cases operated upon, he had been able to gain a great deal of information on this point from the site of the ulcer. In the pyloric antrum on the lesser curvature distal to the incisura 94.2 per cent of the ulcers were histologically malignant. Proximal to the incisura on the lesser curvature only 40 per cent of the ulcers were malignant. Thirty-five per cent of the high-lying lesser curvature ulcers had an associated hour-glass, which confirms their benign character, as they must have been present for a very long time to produce sufficient scarring to result in an organic hour-glass.

In an analysis of all the cases of gastric ulceration which came to his surgical ward including those which they were certain were frankly malignant, 76 per cent of the total incidence of gastric ulceration were due to malignancy.

He had divided this series into two time periods—the first prior to January, 1927, and the second from January 1927, to June 1932, inclusive. In the first period, 43 per cent of the cases were resected. Thirty-eight per cent of these cases were resected with no assurance of cure. Five per cent, however, they felt had an assurance of cure, as indicated by freedom from metastases in the lymphatic glands. Since January, 1927, they had been encouraged to increase their efforts towards resection, and 56 per cent were resected during this period. Ten per cent showed very minor evidence of lymphatic

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involvement, which leads them to a hope of clinical cure. This is encouraging. They have increased their efforts in resecting more advanced cases because of the fact that with no resection a miserable end awaits the patient, yet the physician is to be encouraged to send such cases for operation earlier, as they have 10 per cent with only minor lymphatic involvement in this period, as opposed to 5 per cent of such cases in the earlier group. In other words, they have increased their chance of cure in 5 per cent of the cases in the second group.

Gastroenterostomy in their hands, with this radical attitude towards doing palliative resections in the advanced cases, has been used in a small percentage of instances. In the cases in which they have carried out a gastroenterostomy, the average duration of life has been four and a half months, with probably not more than four or six weeks of freedom from distress.

They have had a somewhat different experience from Doctor Lahey, in that they have reports from their radiologists stating that ulcers which are ultimately proven to be malignant have entirely disappeared under medical care, as far as their presence can be determined by radiological examination. Therefore it is very important that if they have, by non-surgical measures, caused the radiographical evidence of ulcer to disappear, such a patient should be brought back, preferably in four and certainly not later than six weeks after the ulcer is healed. Failure to do so will cause to be overlooked malignant ulcer, which will recur within this time.

The recognition of two types of gastric carcinoma is important. First, the massive type with great bulk and minimum ulceration; secondly, the type associated with maximum ulceration, minimum bulk, and marked peri-ulcer inflammatory reaction. It is in this latter group where the radiographical evidence of ulcer may be eliminated by non-surgical therapy, because the major factor in the ulceration is the result of the inflammatory reaction around a relatively small carcinoma. If an ulcer which has been apparently cured recurs within three months, it should be considered as a malignant ulcer, and a radical gastric resection carried out.

DR HOWARD LILIENTHAL (New York City) said he had just a word on recognition of metastasis. Doctor Maes stated that metastasis could not be discovered until a laparotomy was performed. There are two ways in which metastasis may be discovered before that time. One is the discovery of an enlarged subclavian triangle node in the Virchow's gland. He had several times saved patients from laparotomy by removing a carcinomatous gland in this region, having it examined and proven malignant.

Another point is the X-ray examination of the chests of these patients. Even a small metastasis in the lung can easily be found, much more easily in the lung than in almost any other part of the body and this may save the patient from an unnecessary operation.

DEAN LEWIS (Baltimore, Md) remarked that the villain in this tragedy is the insidious onset and course of the disease. Many patients do not know that they have the disease until so late that the tumor is inoperable. It is still true, as stated many years ago, that the carcinoma which receives early treatment is the one at the pylorus which causes early pyloric block. In other situations the patient may have dyspepsia or some distress which he has had before and from which he has recovered spontaneously, or after having taken some medicine, patent or otherwise. He had recently operated upon an old colored man who said that he had been sick only three weeks. He asked him why he had not consulted a doctor. His reply was, "Doctor, I haven't been sick." There were peritoneal metastases with free fluid and metastases to the liver. In another recent instance he had operated upon a man with an inoperable carcinoma—inoperable because so adherent to the pancreas and the posterior abdominal wall—and this patient stated definitely that he had his first symptoms only three weeks before he consulted his physician.

Doctor Lewis had given some thought as to the ways which might be employed to increase the operability of carcinoma of the stomach and had about come to the con-

clusion that to raise the operability much each patient would have to be provided with a doctor who would attend him constantly. Even then he was sure that there would be a high percentage of inoperability. The insidious onset and progress of the disease account to a large extent for delay. Patients don't visit doctors, as a rule, unless they are sick, and one cannot make a diagnosis unless one sees the patient.

DOCTOR MAES (closing discussion) said that his paper represented the population of a large general hospital as it is viewed in cross section, and it should be interpreted as another plea for the early diagnosis of cancer of the stomach. It was time for surgeons to wake up, to rely upon themselves and their clinical facilities more, to depend upon the refinements of radiological and laboratory diagnosis less. He was not decrying their worth, but he said they should not be the first consideration, nor should they be one's only guides. The safest decision is made with the abdomen open, and until one learns to operate on suspicion in this disease, and to teach the gastroenterologists and the internists to urge operation on suspicion, he shall not reduce its ravages.

Just how poor the present results are is shown by the figures in this paper. Only a fraction of the 200 patients studied in it had any chance whatsoever of cure, and until the entire mode of procedure is revolutionized, they can expect no change in those appalling conditions.

# THE TEN-YEAR SURVIVORS OF RADICAL MASTECTOMY

BY FRANK S. MATHEWS, M.D.

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A YEAR ago a paper<sup>1</sup> was presented to this Association containing the results of the operative treatment of carcinoma of the breast from 1913 to 1932 inclusive and it has seemed desirable to present a further study restricted to the group of ten-year survivors of 1913 to 1923, inclusive. In this period of eleven years 115 patients were operated upon or, if incomplete operations are excluded, the number is 108. Of these twenty-eight have survived for periods of from ten to twenty years. The percentage of survivors of the ten-year period is just over 25 and it is interesting to see that the modern surgical results of different operators do not depart far from 25 per cent for ten-year cures.

The surgeon and particularly the friends of the patient wish to know at the termination of the operation what the outlook is for life and health and in this paper we consider so far as possible the factors bearing on the prognosis, based on the work of others and a consideration of these twenty-eight cases.

*Early Operation*—If treatment is neglected, the patients face a mortality rate of 100 per cent. Hence the sooner treatment is instituted the better the prognosis. This point needs no elaboration. But the practical point really is how are we to get the patients for earlier operation. There is considerable debate as to whether as a result of the campaign of publicity the patients are coming earlier than they did fifteen or twenty years ago. On this subject there is no unanimity of opinion. McCarty<sup>2</sup> has discussed this subject, using as evidence the size of the tumors of patients appearing at the clinic now and fifteen years ago. According to him, accurate measurements show no evidence that the size of the tumors coming to the clinic is less than in former years. Our own impressions are the same based on the percentage of patients showing lymph-node involvement at the time of operation. This seems the more remarkable when one compares carcinoma of the breast with some other surgical diseases. For instance, our operations for acute appendicitis are now very largely performed within twenty-four hours of the appearance of symptoms. Twenty years ago this was certainly not the case. In looking over the list of thirteen carcinomas of the breast operated on within the last year we find that ten of the thirteen showed glandular metastases. One patient had bilateral carcinoma, another carried the disease during the nine months of pregnancy, a third had a sloughing tumor scarcely suitable for palliative surgery, a fourth sought operation when axillary nodes were detected, no tumor having been detected in the breast, a fifth had a large tumor with involved glands and peau d'orange over the growth. Perhaps two

cases might be spoken of as fairly early. The cases of 1913 could have made no worse showing. Sometimes the delay is to be credited to the patient and perhaps necessarily as in the case in which the patient felt an axillary mass but could detect none in the breast. The physicians come in for their share of criticism. We do not blame them for their inability to diagnose early carcinomas especially when their type of practice leads them to see breast tumors infrequently, but what is shocking is that the physician, knowing himself inexperienced, is willing to assume the responsibility for observing these patients over varying periods until the diagnosis becomes conclusive. It may be that they go to their text-books of surgery and see pictures showing swollen arms, large and ulcerated tumors, carcinoma en cuirasse in general terminal conditions the text-book not even mentioning that the breast cancers with which we can best surgically contend will show nothing in a picture. Strange to say, the private patients are not as a class arriving much earlier than the clinic ones. Some of the early cases come from the clinics and are discovered by the younger men of either medical or surgical training who have been disciplined in the making of routine thorough examinations. Another cause of delay is due to the submission of some of the cases to a trial of radiotherapy.

*Functional Activity of the Breast*—At times it has been tacitly assumed that functional activity of the breast is detrimental and may in some way be concerned in the origin of a breast cancer. Lane-Clayton<sup>3</sup> has investigated the subject statistically. She says "We may therefore conclude that the fertility of the patients in the present investigation is definitely lower than for non-cancerous patients." Summers<sup>4</sup> believes that carcinoma of the breast is proportionately more common in single than in married women of the cancer age and presents evidence based on a consideration of statistics showing the number of single and married women over thirty-five years of age in Pennsylvania. He has compared these with the deaths in the state from breast cancer and finds the single patients contributing a disproportionately large number of the total deaths. Among our twenty-eight survivors of operation 50 per cent are known to have been single or married and childless and information is lacking regarding some of the rest. The statistics mentioned and our own would suggest that the child-bearing group has an advantage from the standpoint of tendency to breast cancer.

*Prognosis as Related to Age of Patient*—There is a rather fixed belief that cancer in general proves more malignant in young persons than in those of later years and this has been maintained in particular of cancer of the breast. Some evidence has been presented to that effect but it has seemed to me that the anecdotal method has been depended upon to a large extent instead of statistical evidence. Sistrunk and MacCarty<sup>5</sup> divided their 218 cases into those over fifty years of age and those under fifty years of age and they give a survival value of from five to eight years among the older group as 41.7 per cent while the survivors under fifty years for a corresponding time was 31.8 per cent—a very noticeable difference. Major

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Greenwood<sup>6</sup> has analyzed 273 cases with regard to age, dividing the patients into ten-year groups beginning at twenty-five years, and he finds no great difference in the length of life among the younger, his conclusion being "It will be seen that either there is no significant relation of age at onset and duration of life or at least these data are not numerous enough to establish it" Lane-Claypon<sup>3</sup> has studied 2,006 cases and divides her subject into those under forty, forty to fifty-nine, and sixty or over and concludes "The results obtained in this large series of cases show that the statement commonly made that the prognosis is worse in the young is erroneous" Lewis and Rienhoff<sup>7</sup> also have divided their patients, numbering 573, into decades and find the ten-year survivors in each decade about the same except that those from seventy to seventy-nine have done better than the other groups as regards survival Table I is based on an analysis of the twelve youngest

TABLE I

		Age	Node In- volvement	Grade	Duration of Life
Case 1	L	32	Yes	I	17 years
Case 2	L	26	No	I	8½ years
Case 3	L	28	No	II	7 years
Case 4	D	28	Yes	III	1 years
Case 5	D	31	Yes	III	3¼ years
Case 6	D	33	No	II	8 years
Case 7	D	28	Yes	II	2¼ years
Case 8	D	29	Yes	I	9½ years
Case 9	D	30	Yes	II	3½ years
Case 10	D	32	No	II	4 years
Case 11	D	33	No	III	1¾ years
Case 12	D	32	Yes	I	4 years
Average					5 83 years

Fifty-one cases with ages from fifty to fifty-nine lived 4 9 years average to date Nine cases still living

patients in my series of 230 operative cases It shows three patients still living and an average length of life for the group up to date of 5 83 years For comparison, fifty-three patients with ages of fifty to fifty-nine had an average length of life of 4 9 years Nine of these patients are still living We are not then quite in a position to compare averages in the two groups because some patients in each are still living The former group of patients is too small to make a determination of the median length of life in the two groups of cases of much value The median length of life for the fifty- to fifty-nine-year patients is just over 2 5 years, while seven of the twelve in the younger group have survived four years These younger victims of cancer, then, have varied in grade of malignancy, lymph-node involvement and duration of life as have the older patients but in average and median duration of life have behaved as well or better than the older patients

It is further of interest to note that the ten-year survivors have averaged but 48 5 years of age at the time of operation while the average for a series



of 200 patients operated upon was fifty-two. Hence the patients who have survived the longest have had an average age at operation distinctly less than the average age of all the patients afflicted with carcinoma of the breast. It is worthy of mention that there is considerable discrepancy in various groups of statistics as to the age of the beginning of symptoms of carcinoma of the breast. Daland,<sup>8</sup> in his series of 100 untreated patients, gives 57.5 years as the age of onset of the disease. He mentions, however, that a series of figures of fifteen surgeons gives 50.1 as the average age of onset. The average age at the time of operation in our 230 cases has been fifty-two years. It is notoriously difficult in an individual case to obtain even an approximate idea of the duration of the disease. Our point is that the average age of our ten-year survivors is 48.5 at the time of operation, which is distinctly lower than the average age of onset of the disease as arrived at in the various statistical reports. The range of age of our ten-year survivors has been from twenty-nine to sixty-nine, and by no manipulation of the facts and figures can one arrive at the impression that the prognosis is worse in the younger cases.

*Involvement of Axillary Nodes*—Next to early operation the question of axillary-node involvement would seem to be of most importance in estimating the prognosis. In our cases the glands have been involved in 67.3 per cent. Table II brings out the importance of gland involvement very clearly.

TABLE II

*Prognosis as Related to Axillary Nodes*

33 patients without nodes
19 surviving ten years or over—57½ per cent
1 has since died
77 patients with glands
9 surviving ten years or over—11.7 per cent
3 have since died of cancer

Of the nineteen survivors without glands all but one are now living from ten to twenty years while of the nine survivors with glandular involvement, four have since died and three of them from cancer. Harrington<sup>9</sup> reports from The Mayo Clinic in a series of 2,557 cases that 52.9 per cent of the patients without nodes were living ten years after operation while of those with nodes only 14.6 per cent survived for ten years. There is no definite way of determining the average period intervening between the onset of cancer in the breast and the involvement of axillary nodes. There is no doubt, however, that individuals vary greatly in this respect. Sometimes six months has been suggested as an average time between onset and gland involvement. One thing is clinically quite certain that involvement of glands bears no definite relation to the size of the tumor. It does not depend on whether the tumor is mainly scirrhous, or medullary nor do I think that the size of the individual cells of the tumor bears any definite relation to the time of gland involvement. The largest individual cells can easily enough be transported through the lymphatics.

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*Biopsy in Relation to Prognosis*—In neglected cases, diagnosis is easy. Clinical diagnosis early in the disease is notoriously difficult. We do well to learn early in our career that we are unable to make positive diagnoses in early cases though diagnosis is of the utmost importance. In the earliest cases we have only the age of the patient and the possible skin retraction to guide us. The importance of the former is that few breast masses except carcinomata begin after the age of forty-five. We are not in position to let time decide the question nor should we do radical mastectomies on innocent growths, hence the necessity of biopsies—and by this I mean only biopsies made with the stage set for the radical operation. As time has gone on we have felt more and more the need of making the pathologist an integral part of our operating-room team. The macroscopical appearance of the tumor is usually sufficient but certainty is what is needed, hence the necessity for confirmation of clinical opinion based on frozen section diagnosis. Sometimes it is suggested that the prognosis is impaired by biopsy. On the other hand, Eggers<sup>10</sup> has maintained that the prognosis is improved if a discreet tumor is first widely excised preparatory to proceeding with a radical mastectomy. He thereby hopes to forestall dissemination during the manipulation incident to mastectomy. Assuming that we must do biopsies, we have to consider three procedures: incision of the tumor, wide excision, and simple mastectomy. All three of these have been resorted to one or more times in our ten-year survivors. The total number of biopsies on these ten-year cases has been 50 per cent. We would not advise incision even though the wound edges are immediately cauterized nor do we like simple mastectomies as it seems to complicate a subsequent radical operation more than a generous removal of the tumor would do. Experience with biopsies has not led to the conclusion that any harm has resulted from its employment and it seems as if it must be resorted to in all but the perfectly clear cases. Biopsy with an intervening period of days or weeks before radical mastectomy is done is undesirable from more than one standpoint.

*The Pathology of the Tumor*—We have been accustomed to say that prognosis depends in large measure on the morphology of the tumor though nowadays we prefer to speak of the biology rather than the morphology, a consideration of the morphology being used to foretell the biology replacing the static term by a dynamic one. In past years it must be admitted that such terms as "medullary," "adenomatous" or "scirrhous" as applied to tumor have had no prognostic importance, neither were they related in any regular way to early or late lymph-node involvement. Greenough<sup>11</sup> has classified cases according to these characters and found them of no prognostic significance. On the other hand, the terms "gelatinous," "papillary" or "cystic" as applied to the tumor would suggest a malignancy below the average. In our twenty-eight patients surviving ten to twenty years, three are recorded as gelatinous carcinoma, one is now living, one lived ten years, another sixteen. And there are records of twenty and more years of survival. There was one of the sweat-gland type, the patient still living and well. The terms

"papillary" and "cystic" recur frequently in the reports, and "scirrhous" does also. Different portions of the same tumor may show widely different morphological appearances. On the other hand a metastasis in the glands may closely reproduce the characteristics of an original tumor. This brings up the subject of tumor grading, a subject which is still under investigation. The comparative factors are still only partly established. We have been fortunate in having the series of breast carcinomas graded by Dr. Cushman W. Haagenson, of the Institute of Cancer Research, New York. He graded the tumors of about 200 patients on whom I have operated and whose clinical history is known up to date but the grading has been done without knowledge of the clinical result till after the grading was complete. Table III shows

TABLE III  
*Grade of Malignancy—Ten-Year Survivors*

Grade I	17 cases
Grade II	8 cases
Grade III	1 case
Not graded	2 cases
Total	28 cases

especially the frequency of Grade I of malignancy and that one patient who survived eighteen years and has died of apoplexy was in the third grade of malignancy with nodes involved. Table IV shows the factors which were considered in the grading and, though Haagenson's own paper on the grading of these tumors should be referred to as giving the details of the methods, and

TABLE IV  
*A Plan for the Histological Grading of Carcinoma of the Breast*  
By Dr. C. W. Haagenson<sup>13</sup>

Cell morphology	{ Size of cells	
	{ Size of nuclei	
	{ Variation in size and shape of cells	×
	{ Hyperchromatism	
	{ Number of mitoses (average number per high-power field, 10 by 40 magnification, Zeiss)	×
Manner of growth of cells	{ Papillary character (papillary adeno-carcinoma arising in a cyst formed in a duct)	×
	{ Adenoid arrangement of cells (for form acini)	×
	{ Comedo character (growth mainly within ducts, often with central necrosis of cells)	×
Reaction of stroma	{ Secretory activity of cells (vacuoles in cytoplasm)	
	{ Fibrosis	
	{ Hyaline degeneration	
	{ Gelatinous degeneration	×
	{ Lymphocytic infiltration	

The characters marked × are found to be the most important ones in prognostic grading

their results, we have marked those which he has found most significant. It will be noticed that it is the characteristics of the tumor-cells rather than the reactions of the stroma which are of greater weight.

Among the twenty-eight survivors there have been nine patients who during their subsequent course have had recurrences. Four of these patients have died from carcinoma. To illustrate, a comparatively small group of patients who develop here and there metastases, usually near the first operative field, are then operated on from time to time for recurrences before exhaustion, ulceration, sepsis or internal metastases terminate the case. Only one patient of the group has died from intercurrent disease. She has succumbed within the past month, eighteen years after operation, at the age of seventy-six, from apoplexy. With few exceptions minor operations for local recurrences have accomplished little though one patient has survived her secondary operation for a tumor near the scar for ten years. It seems better to use radium or X-ray in such cases.

*Bilateral Tumors*—There is something intriguing about the group of bilateral carcinomas. They occur in about 6 per cent of breast cancer patients or, otherwise stated, they constitute about 9 per cent of the total recurrences. It has impressed me that they belong to two groups. The first and larger is the group in which the carcinoma by permeation passes the middle line of the body to involve breast, skin, fascia and nodes of the opposite side—one or all. These tumors are clearly dependent upon the first tumor. The second group is no doubt smaller and impresses one as being composed of cases in which the patient develops a new tumor. Among our twenty-eight patients, four have developed tumors of the opposite breast with characteristics that make one think of new tumor. Sampson Handley<sup>12</sup> has called attention to cases in which the glands of the opposite axilla were involved without involvement of the opposite breast. Moreover, there is no group of so-called "trunk lymphatics" connecting the two breasts. In fact, we think of the lymphatics of the middle line of the torso as similar to the blood-vessels crossing the middle line and being in the main inconspicuous. The conditions which suggest that the second tumor is unrelated to the first are: First, the long interval between the first and second tumor, second, that there has been no evidence of recurrence on the side of the first operation, third, that the tumor at its origin has developed in mammary-gland tissue rather than in the subjacent fascia or lymph-nodes. One patient was seen eleven years after operation with a carcinoma of the opposite breast which spread to skin and axillary nodes and developed a local en cuirasse appearance. Another patient sixteen years after operation for a small carcinoma with a single axillary gland involved has four months ago been operated on by Dr. Jonathan Wainwright for a tumor fairly circumscribed in the opposite breast. Multiple carcinomata are now not infrequently recognized and they might be still more common were we more often successful in curing the first. It is a fairly general rule that locations in the body which are frequently the seat of primary growths are not the usual seat of meta-

stases and vice versa. For instance, we should not expect a carcinoma of the breast to metastasize to the lip or uterine body. A mention of two illustrative cases may not be amiss. A patient operated upon for carcinoma of the breast and with no signs of local recurrence died five years later following hysterectomy for carcinoma circumscribed in the uterine fundus. A patient with carcinoma of the cervix was operated upon seventeen years ago by abdominal hysterectomy and has this winter succumbed to thoracic metastases following a local removal of a carcinoma of the breast a year and a half previously. Moreover, though no great importance is attached to the observation, it may be said that the grading of the tumors and the characteristic microscopical picture has not always been the same in the first and second tumors.

It is difficult if not impossible to prove that carcinoma of the second breast is not a metastasis but when the interval is long and there is no sign of local recurrence, the presumption seems to favor the view of a second primary tumor. The fact that animals can be immunized to transplantable tumors would suggest that the factors of bodily resistance and perhaps a local susceptibility of tissue should be considered in these cases.

*Summary*—The average age at which women are attacked with cancer of the breast has been variously stated at anywhere from forty-five to fifty-seven and a half years of age. The modal age of onset (Lewis and Rienhoff), that is, the year in which the greatest number of cases occur, is forty-seven which probably is not very different from the average age of onset of the same cases as will be seen from an inspection of their graph. The average age of our cases at the time of operation is fifty-two years.

The average expectation of life if carcinoma of the breast is untreated is thirty-eight months (Greenwood) or forty months (Daland). The median duration of life (the time at which half the patients are living half dead) is less than this, and according to Daland is thirty months. The median duration of life following operation is scarcely three years though the average is considerably longer.

The abrupt fall in the percentage of survivors in the first, second and third years following operation is due largely to the lateness of operation with gland involvement of many of the cases and to some extent is due to the elimination of patients of higher grade of malignancy. About 40 per cent of cases operated upon may be expected to live for five years and 25 per cent for ten years. The deaths between the five- and ten-year period are mainly carcinoma and to a very small extent from intercurrent disease. If a patient survives for five years from the date of operation, her expectation of living five more is  $62\frac{1}{2}$  per cent, and if her nodes are not involved at the time of operation, her expectation is even greater.

The group of five- and ten-year survivors will contain some cases of each grade of malignancy and some patients with glandular involvement but the favorable results will be largely confined to the patients with Grade I tumors.

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as regards malignancy and who, at the time of operation, were without involvement of axillary nodes

The younger patients, contrary to common belief, do quite as well following operation as the average patient. A few of the oldest develop a very slowly advancing type of carcinoma.

Biopsies must be done on early cases of carcinoma to prevent us from doing too much or too little for breast tumors.

Grading of tumors has developed a prognostic significance.

Gland involvement is still our most reliable factor in determining the prognosis, which is not very different from saying that the early cases do better than the later ones.

Patients may develop multiple malignant tumors either simultaneously or in sequence and it is quite likely that some of the late carcinomas of the second breast are not recurrences but new tumors.

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# THE INCIDENCE AND MANAGEMENT OF STONES IN THE COMMON AND HEPATIC DUCTS

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UP TO the year 1926 we had operated upon 619 patients for biliary-tract disease (infection and stone) In this group we opened the common or hepatic duct to remove or explore for stones in 15 per cent of the cases As the result of these investigations of the ducts, stones were discovered and removed from them in 8 per cent of the cases The mortality in this group was 5.6 per cent

In looking over our follow-up figures at this time, I became impressed with the fact that a good many patients had persisting symptoms of cholelithiasis following cholecystectomy, due to stones being left in the ducts We therefore began to investigate hepatic and common ducts more generally and upon less and less positive evidence of the probable presence of stones

A table is submitted showing the gradual increase in the number of cases in which the ducts were opened, together with the percentage of cases in which stones were demonstrated and removed, and the mortality rate for each period

Years	No of Cases of Duct Stones	Percentage of ducts opened	No of Stones found	Percent	Total Cases	Gall Stone Mortality
1910-1926	96	15.5	52	8.4	619	5.6
1927-1928	91	32.7	38	13.7	278	14.5
1929	49	35.8	22	16.1	137	3.6
1930	61	42.5	30	21	138	2.1
1931	45	38	22	19	116	3.4
1932	52	46	24	21.2	113	1.7

The recent autopsy figures of Crump<sup>1</sup> in Surgery, Gynecology and Obstetrics as to the incidence of common- and hepatic-duct stones in gall-stone cases as demonstrated in 1,000 subjects at the autopsy table are interesting to compare with our operative figures showing the close relation of the finding of stones as demonstrated at operation and at autopsy In this study of 1,000 consecutive autopsies on subjects between eleven and ninety-four years of age, gall-stones were found in 325 cases, and stones were found in the ducts in seventy-eight, or 24 per cent of the cases having stones

We must assume, I believe, from the above figures that we were leaving a common- or hepatic-duct stone in at least one in any ten cases of gall-stones upon which we operated prior to 1926 This, in my opinion, is a very undesirable situation, since a stone, particularly at the lower end of the common duct at the ampulla, is not only capable of bringing about a serious

<sup>1</sup> Crump, George Curtis Surg, Gynec, and Obst, vol III, pp 447-455, October, 1931

## STONES IN THE BILIARY DUCTS

situation, but in many of the cases it is the stone which is producing the symptoms for which the operation is done

In an analysis of our cases of common-duct stones published in the *Jour Am Med Assn*, November 22, 1930,<sup>2</sup> it was found that in 39 per cent of the patients in whom common- or hepatic-duct stones were found and removed, no jaundice was present at the time of operation, nor was there a history of jaundice previous to operation in these cases

A recent study of the cases in the years 1931 and 1932 showed forty-six cases in which common- or hepatic-duct stones were removed, and in 37 per cent of these no jaundice was present either at the time of operation or in the past history

One must conclude from these figures that the absence of jaundice is by no means a trustworthy argument against exploration of the ducts for possible stone. When in over a third of the cases in which duct stones were discovered and removed, the feature which has been considered so typical of the disease (jaundice) was absent, it becomes evident that we must frequently explore ducts upon suspicion even when no stones can be palpated in the ducts

In over a third of the cases in which stones were demonstrated and removed but no jaundice was present, we have been unable to palpate stones at the time of operation, and the ducts have been opened and explored without any positive evidence of the presence of the stones. We have removed stones now so often from the lower end of the common duct at the ampulla in the absence of jaundice, and without being able to say definitely that they were there either from the history or by palpation of the ducts, that we are no longer surprised when a stone forcep or sucker passed down the common duct in a case in which stone would ordinarily not be suspected is withdrawn with a stone in it

This experience has necessitated for us the establishment of a new set of criteria as to indications for opening and exploring the common and hepatic ducts when cholecystectomy is done for gall-stones. With that in mind we have formulated the following set of indications

We believe that when cholecystectomy is being done for gall-stones, the common and hepatic ducts should be explored (1) whenever on palpation one can, or suspects that he can, feel a stone in the duct, (2) when the common duct is dilated, and when the common duct is definitely thickened. We believe that the longer infection and stones have been present in the gall-bladder, the more frequently will stones be found in the common and hepatic ducts, for which reason the ducts should be opened and searched for stones whenever the gall-bladder is found thickened or contracted. Thickening of the head of the pancreas from whatever the cause makes palpation of the lower end of the duct for stones uncertain and unreliable. In such cases, also, we believe the common duct should be opened and its lower end explored

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<sup>2</sup> Clute, H. M. *Jour Am Med Assn*, vol. LCV, pp. 1568-1570.



(3) Obviously we believe that the duct should be opened and explored in all patients with gall-stones who are or have been jaundiced

We do not wish to present any extensive discussion of operative procedures to this experienced audience. There are, however, certain technical

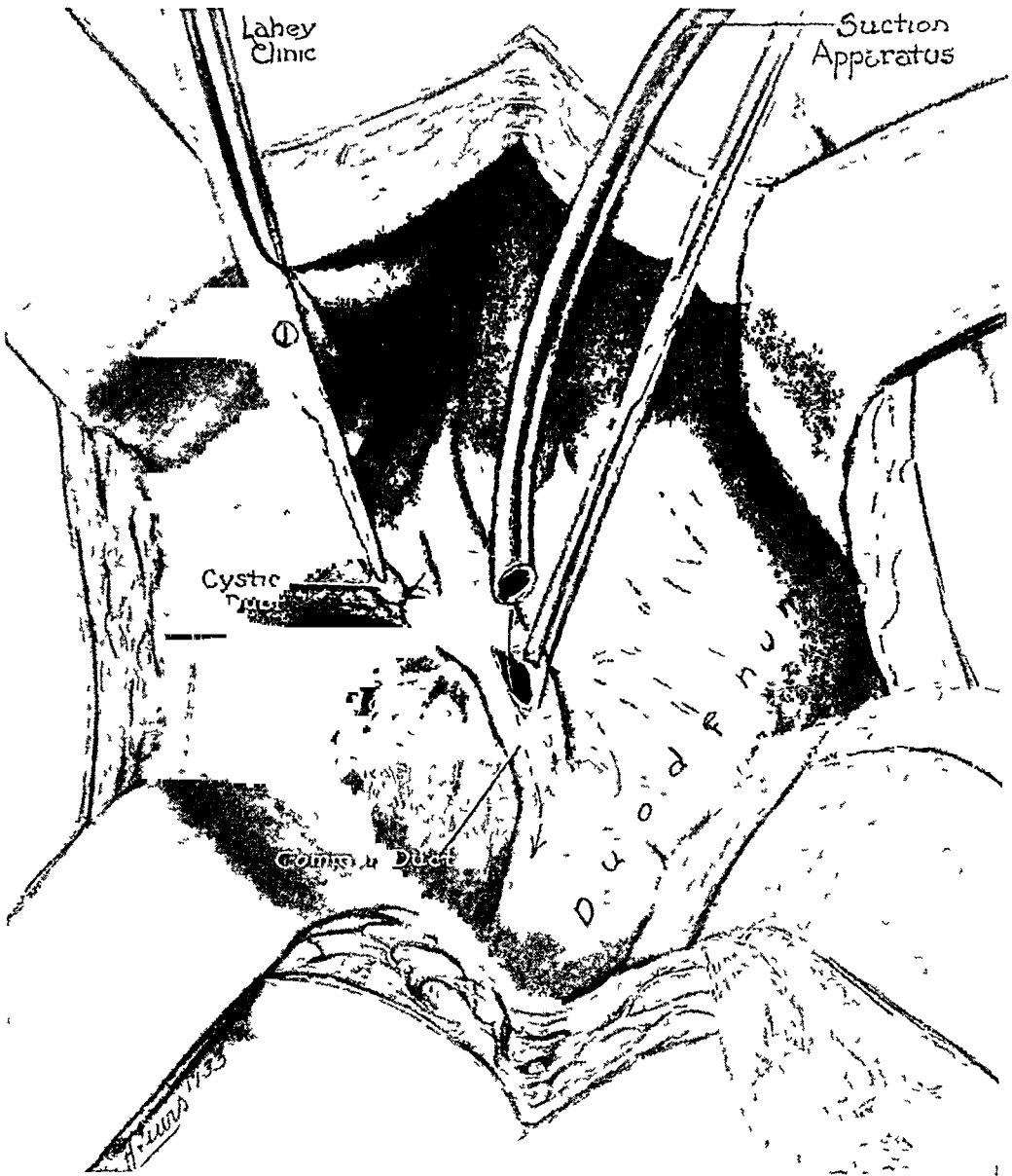


FIG 1—Showing the large opened end metal suction tube to be passed down the common duct to the ampulla where stones are so commonly overlooked. Note the packing which walls off the foramen of Winslow and also catches any infected material coming from the common duct when it is opened. With proper suction technic there should be no contamination of the subhepatic spaces with this material one of the causes of subdiaphragmatic abscess.

procedures which have proven valuable to us in this operative experience with 197 proven cases of common- and hepatic-duct stones.

The safest and most satisfactory way to remove stones from the common duct at the ampulla of Vater, where they are most commonly overlooked, is

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by passing instruments through the incised common duct down to the ampulla and withdrawing the stones through the duct. When this is possible—and it usually is—it is a much safer procedure than transduodenal choledochotomy or rotation of the duodenum and incision of the duct on the posterior wall of the duodenum.

Large stones lodged at the lower end of the duct usually cause marked dilatation of the ducts, and so make demonstration of the stones and their removal through the ducts relatively easy.

It is the small stones lodged at the lower end of the ducts which are so often overlooked, in our experience, and it is these cases in which the employment of suction has proven so valuable.

We have for the past few years passed a large open-ended metal suction tube, as shown in Fig 1, down to the ampulla, and in many of the cases

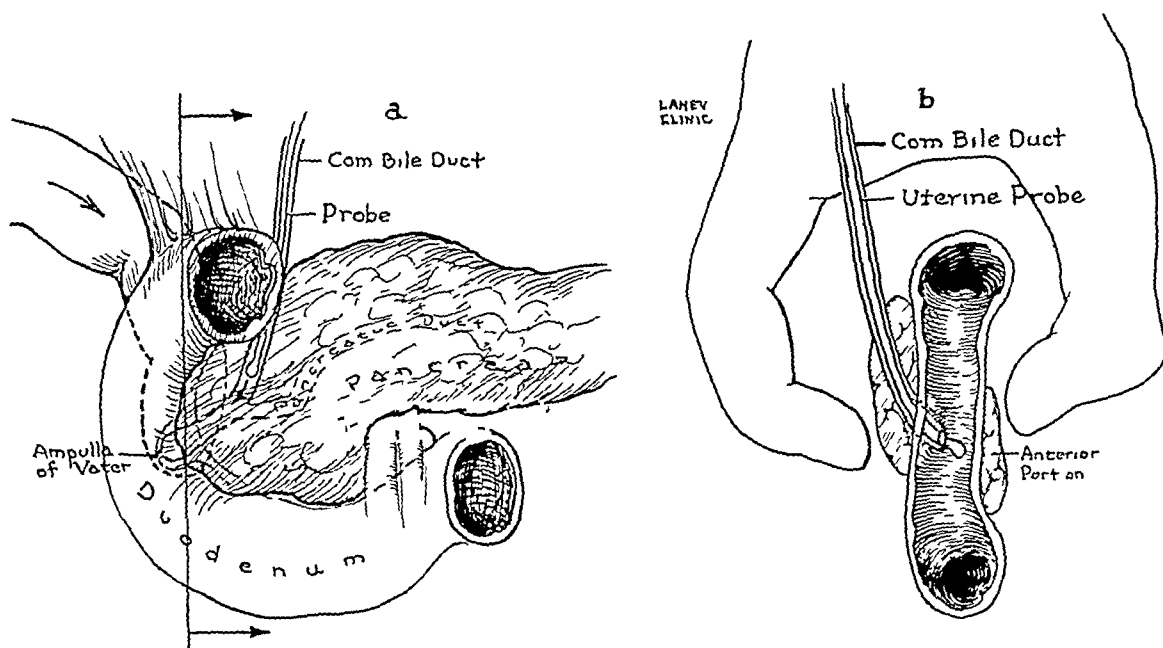


FIG 2—The plan of passing a uterine probe *a* down the common duct into the duodenum *b* and the demonstration of stones at the ampulla by palpating them *b* on the obturator.

successfully extricated small stones with it. This scheme has proven valuable in the removal of small stones which might or might not pass, but when possible are better removed.

Another method of determining the possible presence of small stones at the lower end of the duct which has proven helpful to us is by passing a uterine probe down to and, if possible, through the ampulla. Palpation upon the probe as shown in Fig 2 will then sometimes permit one to feel the small stone as it is palpated against the obturator within the duct.

One of the most difficult decisions to make in patients suspected of having common-duct stones is to advise operation on the unjaundiced patient who has had cholecystectomy for gall-stones, but who still has pain, which is suspected of being gall-stone colic. In such cases one constantly has in mind how chagrined he will feel to have put such a patient through another operative procedure if exploration of the ducts at the second operation proves negative for stone. It is in these patients that duodenal drainage and the

study of the sediment of the material so obtained has proven of such great value to us Dr Allen Wilkinson who has interested himself in this situation, has done duodenal drainage in thirty-two patients in whom such a decision has had to be made On the basis of the demonstration of crystals and bilirubin pigment in all of these cases, he has advised operation Of the thirty-two cases, stones were removed from the ducts in thirty and failed of demonstration in two The study of the sediment of the material removed by duodenal drainage (Figs 3 and 4) has also been of great value to us in making decisions against surgery in border-line jaundiced cases without convincing evidences of stones in the ducts

*Conclusions*—The average incidence of common-duct stone in patients with cholelithiasis is probably in the neighborhood of 20 per cent, and in patients operated upon for cholelithiasis explorations of the ducts should



FIG 3—The duodenal drainage sediment in a patient suspected of and proven at operation to have common duct calcium stones This sediment consists of calcium bilirubin pigment and cholesterol crystals



FIG 4—Cholesterol crystals and traces of pigment in a patient suspected of and proven at operation to have a cholesterol common duct stone

demonstrate stones in percentages which at least reasonably approach this figure if we wish to remove all of the stones

A study of the sediment obtained by duodenal drainage is of value in suggesting the possible presence of common-duct stone

The absence of jaundice and the inability to palpate stones in the ducts are not reliable indications that stones are not present in the lower end of the duct Criteria for opening the duct are suggested

*DISCUSSION*—DR DAVID CHEEVER (Boston, Mass.) said that some three years ago he wrote a brief note in the Archives of Surgery on the instrumental dilatation of the duodenal papilla in order to secure the passage of small calculi into the duodenum He there called attention to a simple procedure to which he did not attach very much importance because he supposed that it was so obvious that everybody practised it, but in going about the country to various clinics he very seldom saw the expedient practised so that he thinks possibly it is worth while to call attention to it

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The duodenum, the gall-bladder and biliary ducts unite to form the common duct which passes down behind the second portion of the duodenum and expands into the ampulla of Vater just before it finally empties by the papilla

A longitudinal incision may be made in the common duct and an effort made to remove with a flexible scoop any calculus which may be present, or if this fails, to milk it up to the incision. If these measures are unsuccessful an ordinary flexible woven silk, olive tipped, hollow urethral bougie is passed into the common duct and down into the duodenum. It is his clinical experience that a No. 10 French bougie represents the normal calibre of the papilla. It is perfectly obvious that if one injects a sterile solution such as saline solution through this hollow bougie, if the tip has not entered the duodenum the fluid will flow back around the bougie and out through the incision in the duct into the depths of the wound whence, of course, it must be aspirated, whereas if the tip of the bougie is in the duodenum the fluid will pass into the gut and there will be no reflux. Having by this test proved that the tip of the bougie with its lateral fenestration is in the duodenum, the instrument is then very gradually withdrawn while the operator at the same time keeps up the injection of fluid watching carefully the incision in the common duct in order to note the first appearance of reflux of fluid which, it is evident, must indicate that the fenestration in the bougie has been withdrawn to a point where it is just within the opening of the papilla. It is usually best at this time to stop the injection, fill the syringe again in order to have ample fluid at disposal, and then inject smartly at the same time rapidly withdrawing the bougie. It is evident that this strong jet of fluid is necessarily exerted and makes pressure beyond any calculus and debris which may lie in the ampulla of Vater and consequently such bodies, as the bougie is withdrawn entirely, are floated up into the accessible part of the common duct whence they may be easily removed.

He had repeatedly used this manoeuvre to float calculi up into the visible part of the common duct. It is a perfectly obvious and simple expedient.

In conjunction with this method it has been his practice purposefully to dilate the papilla with graduated woven silk bougies up to Nos. 12, 14 and occasionally 16 French, always confirming the fact that the bougie has passed through the papilla into the duodenum by the irrigation test above described. This is done in order that any small calculi or debris left in the duct may pass the more readily into the duodenum. It might be thought that a reflux of duodenal contents might occur through the dilated papilla into the duct and thus into the depths of the wound, but he had had only one patient where there was any evidence of such an occurrence and it proved to be not at all serious. However, a few cases have been reported.

DR JOHN HOMANS (Boston, Mass.) offered a suggestion concerning the cystic duct. Sometimes if the cystic duct is particularly long and runs down the side of the hepatic, it may pass nearly to the duodenum before joining it. In one case he found stones impacted in the lower end of the cystic duct which a scoop or any form of suction would have failed to discover if passed into what appeared to be the common duct but which really was the hepatic.

In another case recently he found, after a previous cholecystectomy, a dilated stump of a long cystic duct and a stone in the common duct below which he was quite sure had been overlooked by the previous operator and left in the cystic duct. It had drifted down when the ducts became dilated after cholecystectomy.

Thus, whether or not the common duct is explored, it is quite worth while to find out what sort of cystic duct is left after cholecystectomy, whether there is a considerable amount below the part you see and whether or not a small stone may perhaps remain impacted there.

# THE TREATMENT OF CANCEROUS OR POTENTIALLY CANCEROUS CERVICAL LYMPH-NODES

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THE opening paragraphs of this paper present a summary of our present practice in the care of possibly cancerous cervical lymph-nodes, which is based on what we believe to be competent authority and personal observations made in the care of 473 cases of true squamous or adeno-carcinoma arising somewhere above the body of the mandible, the great majority of which were situated somewhere within the mouth or pharynx

This summary is followed by an analysis of 131 cases of oral cancer, treated before 1930, in which the related lymph-nodes were removed by a block dissection

*Summary of Present Plan of Treatment of the Lymph-Nodes*—In every case of true squamous or adeno-carcinoma arising on the lip, or within the mouth or pharynx anywhere below the level of the mouth slit or anywhere in the cheek lining, the attempt is made to eliminate the possibly infected lymph-nodes preferably without waiting for their metastatic infection to become evident

Whenever it appears practical the primary growth is controlled before the attempt is made to deal radically with the lymph-nodes, but radiation is usually given to the neck areas in the hope of retarding the development of metastases while awaiting the most desirable time to do the neck operation

In certain advanced growths it may be necessary, or seem to be better surgery, to destroy the primary growth and remove the related lymphatic nodes at one sitting, but this procedure gives a higher operative mortality

For growths confined to one side of the mid-line and situated anterior to the foramen cæcum or the posterior faucial pillar, the removal of the lymph-nodes is limited to that side of the neck unless the other side becomes evidently involved

When the involvement is not too extensive, the quickest and most effective way of preventing or eliminating infection of these neck areas is by a painstaking sharp dissection that removes lymph-bearing tissues *en masse*. The presence of palpable carcinomatous nodes does not preclude a fair chance of cure by a well-made dissection, but, if the gland mass has become fixed to the carotid artery, to the vertebræ or the mastoid process, to the larynx, or has gone below the level of the clavicle, then the case is not suitable for a radical neck dissection. The same is true of cases of bilateral neck invasion from a nasopharyngeal growth

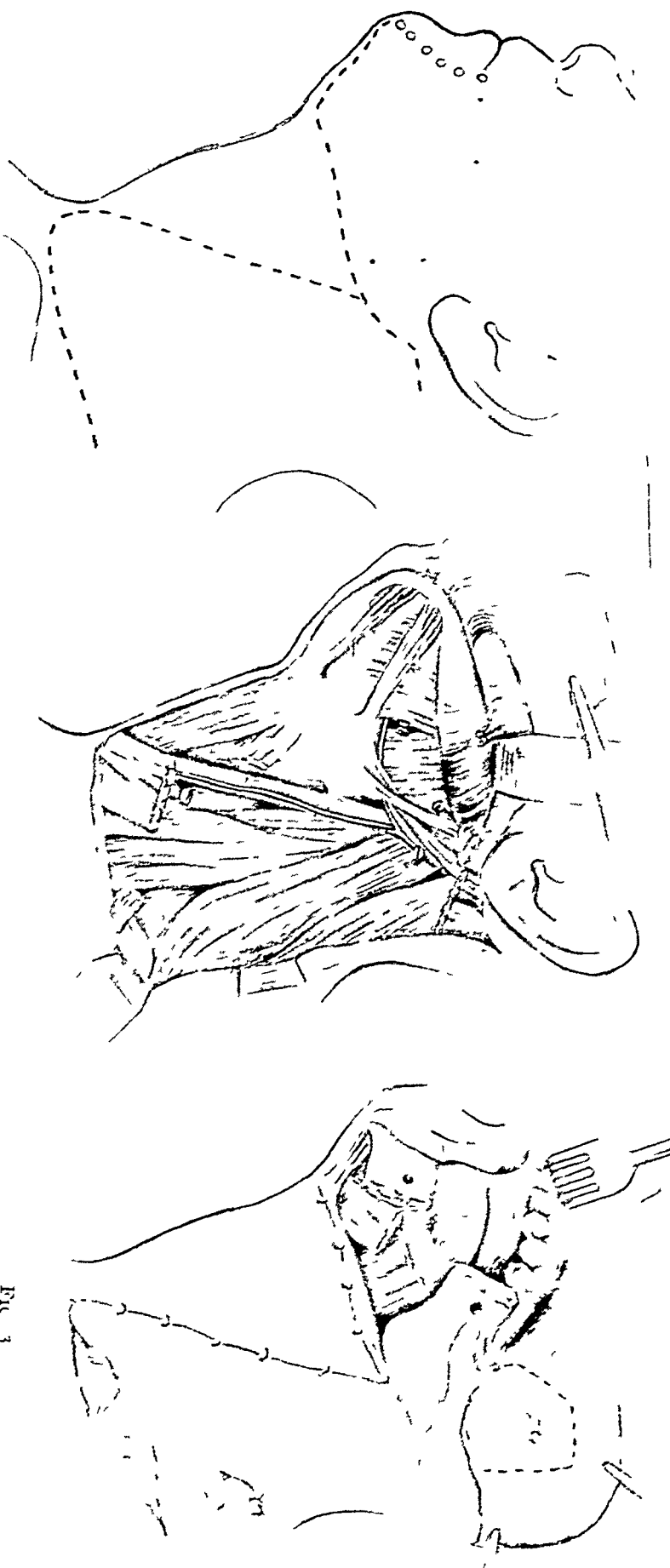


Fig. 1

Fig. 2

Fig. 3

Fig. 1—Shows incisions used for approaching the lymph-bearing areas of the neck and for making a combined removal of the primary growth of the gum, palate or cheek, with the related lymphatics. The dashed line is the approach for a complete removal of the submental, submandibular, buccal and deep cervical lymphatics.

The line of circles through the full thickness and the line of dots through the mucosa, in conjunction with the upper half of the neck. (See Fig. 3) The above exposure in conjunction with a section through the mandible in front of the angle gives a better approach to the posterior part of the lymphatic-bearing tissues of one side and here carried past the cheek, for a wide subcutaneous exposure of the buccal cavity and the upper half of the neck.

Fig. 2—Diagrammatic representation of the operative field after complete radical removal of the lymphatic-bearing tissues of one side and here carried past the midline in the submental region. For spread of operating field also better removal of the sternocleidomastoid and the omohyoid muscles, the descending hypoglossal and spinal accessory, and the superficial cervical plexus of nerves, jugular vein, submandibular salivary gland and possibly the lower one third of the thyroid gland and removed as part of the block excision.

Fig. 3—Shows a plan for the simultaneous elimination of the lymphatics of the neck and destruction of the lymphatic growth that had originated in the cheek, but, at the time of operation, involved also the ilio-coli process, the neighboring part of the tongue and above, the edge of the flap was sutured to the stump of the newly ligated facial artery. The incision alongside of the lip was then completed, the cheek flap elevated and the bone drilled and then divided with a rough saw. The

After completing the neck dissection and establishing drainage, but will have given protection and healing opportunity to the cranial neck and the stump of the newly ligated facial artery. The incision alongside of the lip was then completed, the cheek flap elevated and the bone drilled and then divided with a rough saw. The cheek growth was removed with a cutting cautery, the posterior bone fragment with its attached growth was thoroughly cauterized with a good sized solidating iron, and the tongue was fixed by inserting iodoform needles (but gold iodoform seeds would have been out of preference). In a case in which there are not as many teeth to anchor the lower jaw, the wire that brings the ends into firm contact. Then the wound is closed from the corner of the mouth to the hyoid bone and a hemostatic wire or loop of iron wire that brings the ends into firm contact. Ordinarily, such cases are given ether for the neck dissection in preference to local or block bismuth of Pean iodoform gauze pack in a tent or more. Ordinarily, such cases are given ether for the neck dissection in preference to local or block proper bandaging, will prevent mouth leakage for a week or more. Ordinarily, such cases are given ether for the neck dissection in preference to local or block metastases. For the cautery put chloroform is substituted, the patient having been previously protected by alkalis, lemon juice and sugar. During chloroform the lungs must be protected from smoke by breathing through a large tube one half inch or greater, lumen placed in the pharynx or by blowing chloroform carrying in by means of an atomizer bulb into a stream of fresh air that is pumped continuously through an intertracheal tube. Nitrous oxide oxygen administered through an intertracheal tube could be substituted.

Inoperable lymph-node invasion can frequently be controlled for an indefinite period by the direct implantation of radon or radium within the growth, by exposure to intensive X-ray after turning back the skin that covers the growth, or a combination of both of these plans

We have not, either in our own experience nor in the literature, found evidence that there is at present any other plan of treatment of these cervical



FIG 4—Shows a plan we have recently used when unexpectedly a cancerous gland is found attached to the carotid artery or other irremovable structure and when a radium tube is not then available. A Penfield drain loosely distended with roled gauze is laid in contact with the remaining part of the growth. A string passes completely through the drain with the gauze roll protruding only a little beyond one of the skin openings. One or several days later a properly screened tube of radium enclosed in a gauze roll of similar diameter is drawn into the rubber drain by means of the string and made to fit firmly against the posterior end of the original gauze roll. Then the drain with its contents is drawn forward until the radium carrying gauze is opposite the area to be treated.

glands that has shown itself to be as sure and as lasting in its average results as the old and well-established plan of block surgical removal by sharp dissection

Butlin,<sup>1</sup> following Whitehead, in 1909 summed up his personal experience with the operative treatment of tongue cancer reporting 197 operations with twenty operative deaths and fifty-five patients surviving from three to



Fig. 5—A shows the post operative condition of a man of sixty seven years who had had an extensive epithelioma of the cheek and lower jaw of three months' standing, which had penetrated to the skin and invaded the submaxillary nodes. In this instance the neck dissection was carried down only to within an inch of the clavicle, is shown by the dotted line, and the lower half of the neck was closed as in Fig. 3. The submaxillary skin flap lower part of the full thickness of the cheek, the whole inner part of the cheek, the reflected, areolar process of the mouth, and the full thickness of body and lower half of the lips and middle with the adjacent part of the floor were destroyed with hot solidating irons without previously dividing the bone. The subsequent cure was simplified by the fact that we were able to preserve enough cheek tissue to allow closure of the corner of the mouth. The upper wound was closed with an iodoforn bulbism of Penicillin dressing, and he was fed through the esophageal tube shown in place. Microscopic examination of the glands was negative for carcinoma. Some time later a skin flap was raised from the forehead and sutured back into its original bed. From months later, after the devitalized section of burnt bone could be separated, the skin shown in B and C was made from the forehead flap which also furnishes a complete lining to the cheek allowing the opening shown in 5 C.

It was Dr. Thomas Gibson who called attention to the fact that having the jaws in proper relation to each other for three or four weeks after removing a full section from one half the mandible would prevent the displacement that otherwise would render the remaining part of the lower jaw useless for chewing or proper speech.

In this particular case the jaw bone was burnt completely through because of the extent and depth of the involvement, more frequently deep securing of the bone surface would be sufficient for control of the disease, but it is usually necessary to destroy so much of the cheek lining that subsequent securing would lock the jaws. Complete devitalization of a full thickness section of the bone at this time later establishes a serviceable false joint when it is needed. While the full thickness of the cheek has not been destroyed, it is a simple matter to free and unite the ends of the bone after this bone section is thrown off.



twenty-two years—28 per cent, and analyzing the series in a number of ways that make it worth the perusal of anyone interested in this work. There was and is now great skepticism on this subject. Lack of conviction on the part of either the profession or the public that surgery can be really curative for cancer occurring within the mouth today bears the largest share of responsibility for the advanced stages at which these cases come to surgery. The relatively poor operative showing that can be made with these advanced cases in turn leaves this field open to any plan of treatment which offers any promise of hope, so long as it employs neither knife nor cautery. Within the past decade, radiation has largely predominated the field of treatment but, apparently, with a somewhat genial disregard for what good surgery has accomplished when given a fair chance. While everyone would like to see a selective agent replace mass destruction in the treatment of all cancer, and while radiation in the hands of its more skilled exponents has, in many ways, gone far in this direction, we believe that gross removal or destruction is still our most effective weapon against certain primary mouth cancers and in most of the metastases to the related lymph-nodes.

In support of the above, we venture to offer a none too brilliant showing in a small continuous series of unselected cases operated upon during a period of approximately fifteen years previous to 1930, in the majority of which some sort of radiation was also used either for the cure of primary lesion or at least as an adjunct. Our results do not make as effective a showing as did Butlin's<sup>1</sup> and our death rate is more than double his, but, in extenuation, we submit that but two cases in this series could be classed as early, sixteen were of medium advancement, and 113 were far advanced at the time of our first treatment. The observations of these 131 cases have been somewhat influenced by observations on more recent cases, making a total series of 473. The natural death rate of true squamous-cell epithelioma is 100 per cent, and it comes in forms that entail many months of misery and a train of social and economic disaster. If the above facts are kept in mind, the risk essential to operations of promise becomes less terrifying. No patients were subjected to special risk without having been warned and given an opportunity to choose for themselves.

*Analysis of Death Rate* —In sixty-one cases the primary growth was first removed or destroyed and then the related lymphatic areas of the neck were removed at one or more separate later operations. In fourteen of these cases the cervical growth was so far advanced that they should have been considered inoperable, there were three post-operative deaths (4.9 per cent) and no case lived five years. We would now exclude such cases from radical operation. In the remaining forty-eight cases in which the gland masses were not fixed directly to the carotid artery and had not grossly involved the jaw-bone, there were no post-operative deaths. In another series of seventy cases in which the growth was so far advanced as to require the removal or cautery destruction of the primary growth and the attempted radical removal of the cervical lymphatics at the same operation there were twenty-four post-operative deaths.

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(34 per cent) This mortality suggests that more enthusiasm than discretion was exercised in operating on some of these cases. These twenty-four cases were all advanced cases of the tongue, pharynx and buccal mucosa, and included three common and one internal carotid ligations ten tracheotomies

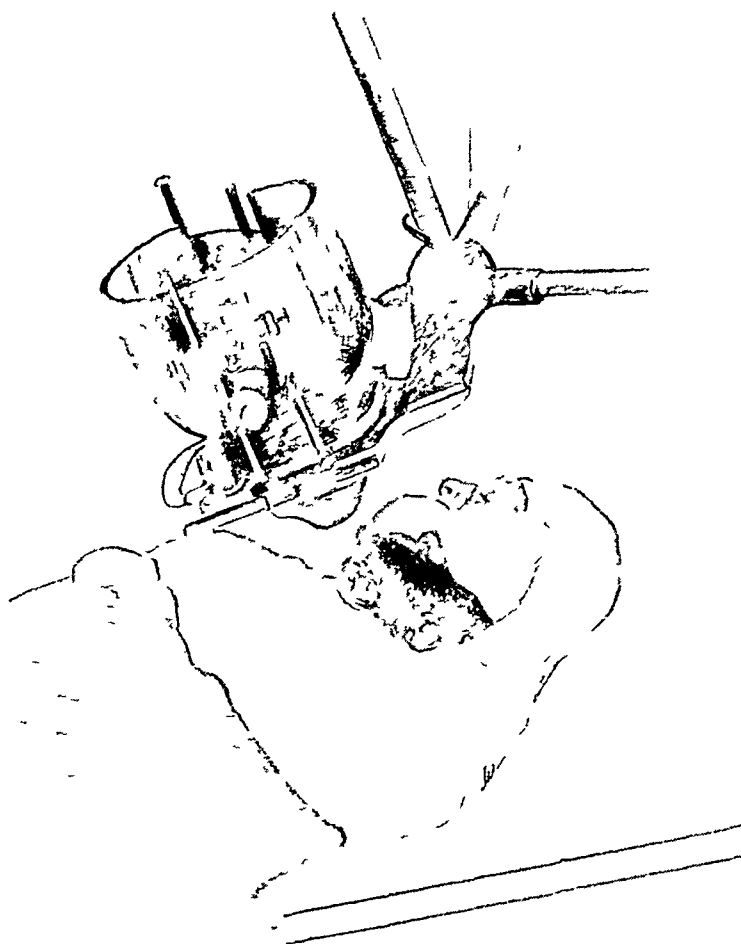


FIG 6—In October, 1919, we did a complete block removal of tongue, floor of mouth submaxillary and submental regions of this patient (of sixty years) for a recurrent epithelioma of tongue, jaw and submaxillary region extending from the last right molar tooth to the second bicuspid on the left, this had been treated with X ray for three months previously. In February, 1920, a radical dissection of the lower left side of the neck was made, and, before closing Doctor Moore exposed the area to X ray, while the skin flaps were still retracted. Microscopical examination of the glands showed undifferentiated squamous cell carcinoma.

More recently in certain cases we have packed the neck open with plain gauze, covering the neck with the regular dressings before sending the patient to the Mallinckrodt Radiological Institute on his way from the operating room. A few hours or a day or so later the pack is removed and the skin wound closed by tying the sutures which are inserted at the time of operation. This patient recovered and remained well and in active business for eight years when a recurrence of a new growth appeared within the larynx from which he died in spite of a laryngectomy, which had been somewhat delayed.

and very radical procedures in all instances. Fifteen patients had definite carcinoma in the neck. The post-operative death rate of both series together is 20 per cent.

*Results of Treatment*—In the above cases of neck dissection in which

gland masses were not fixed directly to the carotid artery and had not eroded the mandible, there is but one recorded recurrence in the neck, 2 per cent. In twenty-one of these cases the glands were found to be positively cancerous and ten patients are known to be well five to fourteen years after operation. In twenty-six the glands were reported microscopically negative and eighteen are known to be well five to eighteen years after operation.

In the series of seventy cases of combined operation, there were sixteen cures of five to eighteen years. In twenty-nine of the seventy cases the glands were apparently negative, with six cures (20 per cent), while forty-one were definitely positive with ten cures (24½ per cent).

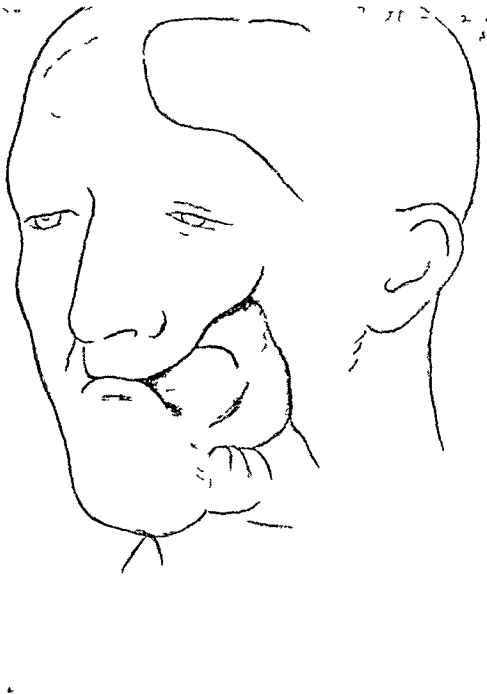


FIG 7A

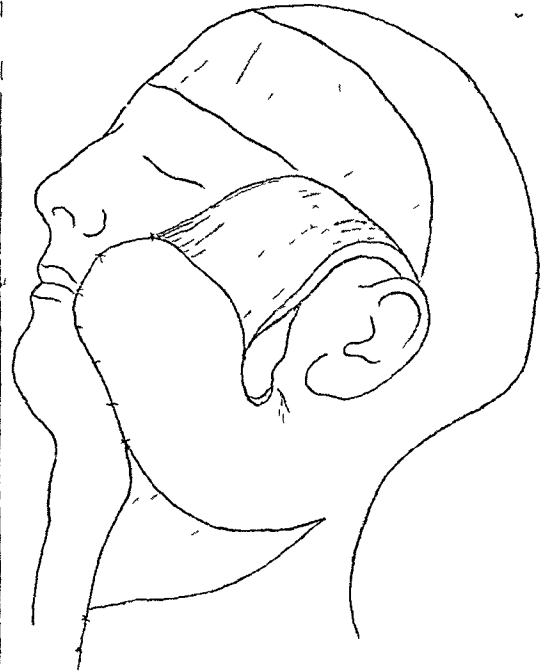


FIG 7B

FIG 7—Male who was fifty seven years of age in 1920 when he was referred with a fungating mass three centimetres in diameter in a rough leukoplakia which covered most of the cheek lining. There was also an ulcer in inner surface of left side of upper lip. The induration extended through the lip and cheek to the skin and there was a mass of hard, related submaxillary lymph nodes. He had consulted his physician seven months previously on account of interference with his dental plate.

*Treatment*—One flap was raised from the forehead and one from the neck to be used for the subsequent repair. The indurated skin area was incised with a cutting cautery leaving one and one half centimetres margin. Retraction of the borders permitted the cheek and submaxillary masses to be removed and the exposed bone to be deeply seared with hot soldering irons. At subsequent steps the cheek defect was closed, the tissues adjusted and the lower neck dissection was completed. Microscopical examination of the glands showed undifferentiated squamous cell carcinoma.

(A) shows the condition several months after removal of the growth. (B) is schematic diagram of the repair, using the forehead flap for the covering and neck flap for the lining.

We have not attempted to search out, combine or interpret, the statistics of published purely radiological cures, but the following 'suggestive results are summarized in the September, 1932, American Journal of Cancer, in an article by Mekie,<sup>2</sup> of Edinburgh viz, Forsell, of Stockholm, in seventy-two cases out of 244 found definite gland involvement, and, in these seventy-two cases, he reports not one cure. Also Quick used X-ray in 161 definite gland involvements with six cures, duration not stated, which, adding Forsell's to Quick's cases, gives 233 radiated cases of known infection of the neck glands.

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with six cures, or 26 per cent Coutard<sup>3</sup> reports forty-six cases of advanced clinical cancer of the tonsillar region, eighty-nine of the hypopharynx, seventy-seven of the larynx—all treated with X-ray with forty-two out of 212 (20 per cent) well over five years This is unique among the published records of radiological therapy for cancer of these areas

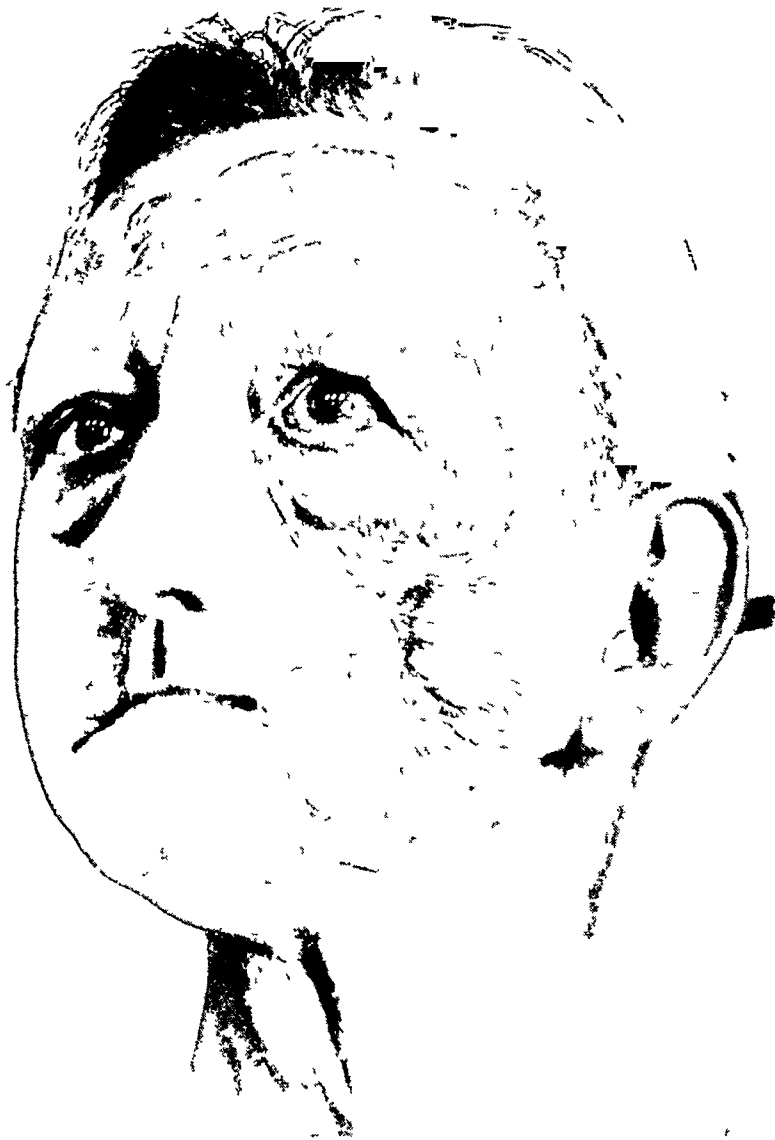


Fig 7C—Shows recent photograph The mouth opens freely There has been no evidence of return in the operated area but in the mucosa of the lips and opposite cheek several isolated nodules have arisen at intervals which were treated with radium or removed on the presumption that they were precancerous Some proved to have gone further than that stage

Compared with the above we believe our series of twenty out of seventy-four cases with secondary lymphatic metastases, 27 per cent, which were apparently well from periods of five to seventeen years after operation, is more than suggestive that there is still a place for radical surgery in the treatment of cancer of the mouth

There is one difficulty that must be considered in attempting to make a comparison between the results of operative treatment and of radiation of the unopened neck. In a case not operated on, the interpretation of the gland condition is not as accurate as where the glands can be taken out and sectioned, although negative microscopical findings are far from 100 per cent correct. A pertinent observation in this regard is that there occur quite a number of late manifestations of gland involvement coming on very often years after a trivial ulcer of the lip or tongue, especially the lip, had been



FIG 8—This patient presented himself eighteen years ago when forty-eight years of age with a fungating recurrence that had been present for four months. He had had the anterior half of his tongue removed for carcinoma five years previously. Excision of the tongue was facilitated by dividing the mandible through the socket of the left central incisor tooth. The amputation was made just at the hyoid bone and the actual cautery was used freely in adjacent portions of mandible hyoid bone and pillars of the fauces. At three later steps the lymph bearing areas of both sides of the neck and the submaxillary and submental regions were removed. Microscopical examination showed poorly differentiated squamous cell carcinoma of the glands and in the tongue. Since recovery he has practiced his profession, taken care of a large clientele being well understood over the telephone. His vocabulary is cut about one third of the normal syllables. His food must be pushed until grasped by the pharynx.

cured perhaps by some application the circumstances of which the patient may have entirely forgotten until questioned. We have a record of but one case coming to us for gland recurrence in an area from which the glands had been removed *en masse*.

Mention might be made here also of two factors which we believe tend to lower the percentage of proven operative cures of cancer of the mouth in comparison with the same treatment of breast cancer. First, many of the

mouth cancers are in old and often enfeebled men who are very poor operative risks, second, the post-operative follow-up is more difficult with these men than it is with women, and their age and condition make them more liable to death from other causes before our five-year period has elapsed. Where feasible, the principle advocated by Butlin, Kocher and others of removing en masse the related lymph-nodes, without waiting for demonstrable lymphatic infection, was followed throughout, but in practice we have followed the radical technic of Crile. Butlin's analysis emphasizes the known fact that the death rate resulting from extensive surgery can often be materially reduced by dividing the operation into two or more steps.

It has been our preference where practical to postpone the neck operation a few months both to permit full operative recovery and also to get further assurance of the immediate control of the primary lesion, but at times disaster has followed this delay in spite of attempted protection by interval radiation. Butlin's figures appear to justify the practice of not always making the two operative fields continuous.

A study of the cases in this series shows that when there was a carotid ligation, associated tracheotomy, removal of a section of the lower jaw or a direct operative attack on the pharynx, operative mortality was greatest. In our present practice we attempt to avoid the above pitfalls chiefly by substituting radon or radium implantation for all primary growths arising in the tongue and floor of the mouth, fauces, pharynx and nasal passages, by using a hot soldering iron for growths involving either jaw-bone or cheek, depending upon subsequent exfoliation rather than immediate removal of the affected segment of bone. Radium can be made to destroy cancer of the bone, but the months of misery that are apt to follow when sensory nerves are not divided make destruction of the bone and its coverings with the soldering iron a somewhat acceptable substitution in most cases. We have had very poor average results with the implantation of radium within the cheek.

After destruction of squamous-cell growths occurring in the lip or mouth below the level of the mouth slit, whether by radium, cautery or removal, and for those occurring in any part of the cheek, a radical block regional glands removal is done either at the primary or at a secondary operation if the patient will submit, and if the operation looks feasible. For squamous-cell lesions above the level of the mouth slit, with the exception of the cheek lining, the gland removal is usually not urged unless cancer-like nodes are present at the time of the treatment of the primary lesion, but the patient is instructed to return for observation at regular intervals. The rather rare adeno-carcinomata and endotheliomata were treated along the same lines, but, for the lymphosarcomata and all of the primary malignancies of the lymph-nodes, no matter how named, we depend upon radiation after the diagnosis is established. These all seem to die within four years at the outside, regardless of the kind of treatment.

Thirteen years ago Dr. Sherwood Moore, Chief of the Edward Mallinckrodt Radiological Institute, first treated one of our block neck dissections,



FIG. 9—Man fifty six years old, with a fixed mass in the upper part of the neck extending from the angle of the jaw to the mastoid and extending one half way down the neck. The skin was not attached, and a very small questionable nodule just at the attachment of the anterior pillar of the tongue was present. The neck mass was uncovered by the incisions shown and the flaps turned back. He was not in good condition and his blood pressure immediately dropped to 60/40 and for that reason a specimen was not cut from the neck but some of the outlying glands were typically carcinoma like in their feel and contour. The main mass was fixed in the neighborhood of the bifurcation of the carotid. Six twelve and one half milligram needles of radium element were pushed into the deeper portion of the posterior surface of the mass and anteriorly a fifty milligram screened tube of radium was placed deeply in relation to the carotid sheath. Long silk worm gut sutures were put in in such a manner that when drawn tight they would close the wound. The flaps were turned back and dressings applied. He was taken to the Mallinckrodt Radiological Institute and given the following X ray dosage 150 KV 30 ma 8 inches 1 area, 0.5 mm copper, Port 20 cm sq distance 50 cm. Total dosage 125 X 8. The total radium dosage was 1750 milligram hours. The neck was closed when the radium was removed. Microscopical examination of the nodule showed a peculiar epithelial hyperplasia but a point of breaking through was not found and the diagnosis of cancer still rests in clinical evidence.

This photograph was taken ten days after the neck was closed when the palpable mass was two centimetres across in its widest diameter.

while the skin flaps remained turned back so as to give direct access of the X-ray to the deeper structures. This, we have had done since sporadically, but with increasing belief as to its usefulness, and of a feeling that it could be made to reduce very materially the operative death rate of certain types of cases that help to make up the present series (Fig 6). If X-ray radiation is ever to displace removal in the treatment of cancerous glands, we believe that this direct exposure will at least for a time be one of the steps in the development of the process.

Until this goal is reached, we are still convinced that, allowing for age and infirmity of the victims and given early cases, good surgery will give as good or better results and with little higher death rate than we now expect from surgery in breast cancer. All mouth cancers should receive early effective treatment, for the majority of such sufferers that we have questioned knew fairly early that something was wrong and were not slow to seek advice from the regular profession.

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# THE USE OF SILK IN THE REPAIR OF CLEAN WOUNDS

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THE wound which in its repair consistently and ruthlessly measures the surgeon's skill, his self-criticism and his effort to attain the ideal, is the so-called clean wound, the wound most commonly made by the surgeon himself in his approach to and his withdrawal from uninfected and uninflamed tissues and structures

A surgeon's percentage of clean-wound healing is not only a measure of his asepsis, but it is an index of his entire surgical philosophy—his knowledge of the principles of healing *per primam*—as well as his attitude towards his patient's welfare and towards the improvement of his art and science of surgery This philosophy is reflected in the surgical clinic of a hospital

The criteria of primary wound healing must be considered before discussing any technic or actual figures of clean-wound healing Healing by primary union may be defined as the restitution of the incised tissues to their normal condition with the least possible scar, and with no discharge of any exudate from the line of incision or from any stitch holes, which either clinically or bacteriologically indicates infection

The second essential criterion is the exact determination and recording of the healing in every clean wound Unless this is done by a conscientious and critical surgeon and by his staff, the impressions or the casual statements made by him or his staff as to the percentage of infected clean wounds will be valueless Unless and until such a record is kept, there will be little if any desire on the part of the surgical staff to improve their technic or to reduce their unknown percentage of infections I speak from an experience in hospitals where no such records were kept, and where the percentage of infections was grossly underestimated, and from an experience of eight years in a clinic in which a careful record has been kept of our clean-wound healing and an annual report made, not only of the total cases on the entire general surgical service, but of the individual operators and in types of operations This is read before the entire surgical staff In passing, let me say that the compiling of this report (Fig 1) is a long and difficult task, and I wish to express the appreciation of our surgical staff to Dr Frank Meleney for his effort during the past eight years to keep up the data and to collect it annually for comparison with previous years When this study was begun in 1925 we were amazed and chagrined to find how many more infections we had than we had estimated Since 1925 there has been a steadily decreasing number of infected clean wounds

Given, then, our criteria of primary-wound healing and accurate records it is possible to analyze success and failure Such an analysis soon creates a

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desire to know why some clean wounds do not heal by primary union, while the majority of others heal without evidences of infection. Of course, the prime and essential reason that the majority of clean wounds heal *per primam* in every modern hospital or clinic is because of the sterilization of the supplies, the solutions, the gowns, the gloves and the instruments that come in contact with the wound and because of the aseptic sense that is developed in the surgical team. It is this sterilization and aseptic sense that eliminates the dreaded pyogenic and the severe anaerobic infections from our clean wounds. The above-mentioned factors are controllable and can be maintained as constant factors by eternal vigilance and supervision, and by unannounced bacteriological check-up cultures of the operating room and team. There are, however, certain mild or so-called trivial infections of clean wounds which do occur often enough to spoil the clean record of 100 per cent clean-wound healing.

### Wound Infections—8 Years

	TOTAL	CLEAN	%	SERIOUS	%	TRIVIAL	%	Tot Inf	%	Hemat	%
1925	558	482	86	20	4	56	10	76	14	27	5
1926	581	494	85	22	4	65	11	87	15	54	9
1927	653	555	85	16	3	82	12	98	15	95	14
1928	640	571	89	10	2	59	9	69	11	80	13
1929	771	703	91	17	2	51	7	68	9	141	18
1930	747	674	90	23	3	50	7	73	10	108	14
1931	950	883	93	16	17	51	5.4	67	71	97	10
1932	1053	997	95	12	1.1	44	4.2	56	5.3	57	5.4

FIG. 1.—Summary of annual reports showing incidence of serious and trivial infections and hematomas

It must be evident that primary-wound healing does not depend alone upon the effort to exclude pyogenic or infective organisms. First, because wounds made in well-vascularized tissues, as in the face and neck, without any aseptic or antiseptic precautions very often heal *per primam*. Secondly, wounds closed with every aseptic precaution, but in which drains or other gross foreign bodies are present, frequently do not heal by primary union. Third, dead or compromised tissue, devascularized by crushing clamps, tight ligatures and sutures or by an obstructed blood supply acts as a foreign body and is frequently followed by suppuration in a wound closed with aseptic technic.

Furthermore it is now well recognized that it is next to impossible to eliminate all micro-organisms, bacteriologically speaking, from the operative wound because of the staphylococci in the sweat glands and hair follicles of the skin and because of the organisms that circulate in the air of an

active operating room and settle in the operating field—the wound or the uncovered instruments, gauze and gloves

Eliminating the controllable factors, heretofore mentioned, how can we reduce to a minimum the factors which predispose to the growth of the occasional pyogenic coccus or bacillus that reaches the wound either by way of the cut skin edges or, as air-borne, to the exposed instruments and supplies and gloves or directly to the wound?

First, in regard to the skin edges I do not in any way minimize the importance of most careful preparation of the skin well beyond the operative field. By meticulous cleansing of the field, first with a grease-removing solution like ether or benzene, followed by green soap and water lathering and then rubbing with a sponge soaked in alcohol, or by the use of 7 per cent iodine after the ether or benzene the skin can be made sterile on its surface, but not always in the deeper glands and follicles. An added safeguard is undoubtedly the careful and effective segregation of the skin edges after the incision is made, by means of dry towels or abdominal pads.

The air-borne bacteria can be minimized by careful masking of nose as well as mouth, and by covering all supply and instrument tables not in immediate and constant use by pedalled canopies. The careful masking of mouth and nose by every one in the operating room we are convinced, because of sad experience,<sup>1</sup> is the most important measure, for it practically eliminates air-borne but virulent streptococci from the noses and throats of the operating team.

The minimizing of foreign bodies and the minimizing of damaged tissue in the wound is the most subtle and difficult part of this subject. It deals with the essence of the surgeon's philosophy and has to do very largely with the reducing to the minimum of clean-wound infections. As we may constantly approach a limit in geometry but never reach it, so in surgery we can minimize, but never permanently eliminate, bacteria in the field. Beware of the operator who says that he never has a clean-wound infection.

William S. Halsted, that great philosopher in American surgery, many years ago discussed this subject and proposed and carried out certain principles in technic which gave him results that have probably never been excelled in clean-wound healing. His few selected and trained assistants, who later developed clinics of their own, followed these same principles. Many others attempted to use this technic, but because of poor results gave it up. The report<sup>2</sup> of his first year's work, which appeared in the Johns Hopkins Hospital Reports for 1890–1891, is an amazing example of accurate observation and constructive surgical teaching. Halsted elaborated and refined the technic which he had learned from Kocher, and so clearly analyzed it that any thoughtful surgeon could understand and appreciate the rationale of his meticulous handling of the clean wound. He stressed absolute sterilization of instruments and supplies, as careful cleansing of the skin of the operative field as possible, and finally the minimum of damage to the tissues in the operative field and to the wound edges. To accomplish the last desideratum he insisted

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upon sharp-knife dissection, complete hemostasis with sharp-pointed artery clamps, the avoidance of mass ligatures of tissue, the avoidance of undue tension on the sutures. Because catgut was so difficult to sterilize at that period and because its absorbability was so uncertain he adopted silk in its finest grades as the optimum material for sutures and ligatures. He found that the use of fine silk improved his wound healing, made his staff more self-critical and favored the accomplishment of the principles essential to clean-wound healing.

The use of fine silk has come to be accepted as the standard in neurological work, where clean-wound healing is rightly considered essential. It is used in many clinics for the thyroid and bone and joint surgery, and yet

### *Summary of Tensile Strengths of Laparotomy Wounds in Rat*

<u>Day</u>	<u>Catgut</u>	<u>Silk</u>
6 hours	20	27
2nd day	25.2	33.6
4th "	17.5	30.0
6th "	68.08	98.68
8th "	70.73	108.61
10th "	87.21	140.76
12th "	101.74	175.95

In all instances in catgut, wounds broke, not the surrounding tissue, up through the eighth day when break was through surrounding tissue from the ninth day on. In case of silk, surrounding tissue broke from the seventh day.

Tearing of actual suture line was up to the sixth day.

FIG. 2.—Summary of tensile strengths of parallel right rectus incisions in varying days of healing in a rat.

catgut continues to be used by the majority of surgeons in the repair of the ordinary clean wounds such as hernia, mastectomy and neck dissections.

Silk must not be used unless the surgeon is willing to carry out certain rigid rules in technic. Errors to be avoided are:

- (1) Tight sutures
- (2) Mass ligatures
- (3) Blunt scissors dissection
- (4) Careless hemostasis with blunt-nosed hemostats
- (5) The use of any but the finest grades of silk. Silk that will not break should not be used.
- (6) The combination of silk and catgut.
- (7) The use of silk in any but a sterile field.
- (8) Continuous sutures.

Silk technic should not be introduced into a clinic for general adoption until the operators have been trained individually in its use. Unless this is done there will be disappointing results, due to faulty technic.

I was not trained in the use of silk technic in my earlier years, but I had

always admired the Halsted school for its contributions to the subject of primary-wound healing. Ten years ago I made the mistake of urging several members of our surgical team to adopt silk technic. Because we did not use the finest grades of silk, ligatures and sutures were tied with too much force, and because of a few infections which were followed by sinuses and long periods of silk extrusion we abandoned its use. Three years ago I adopted

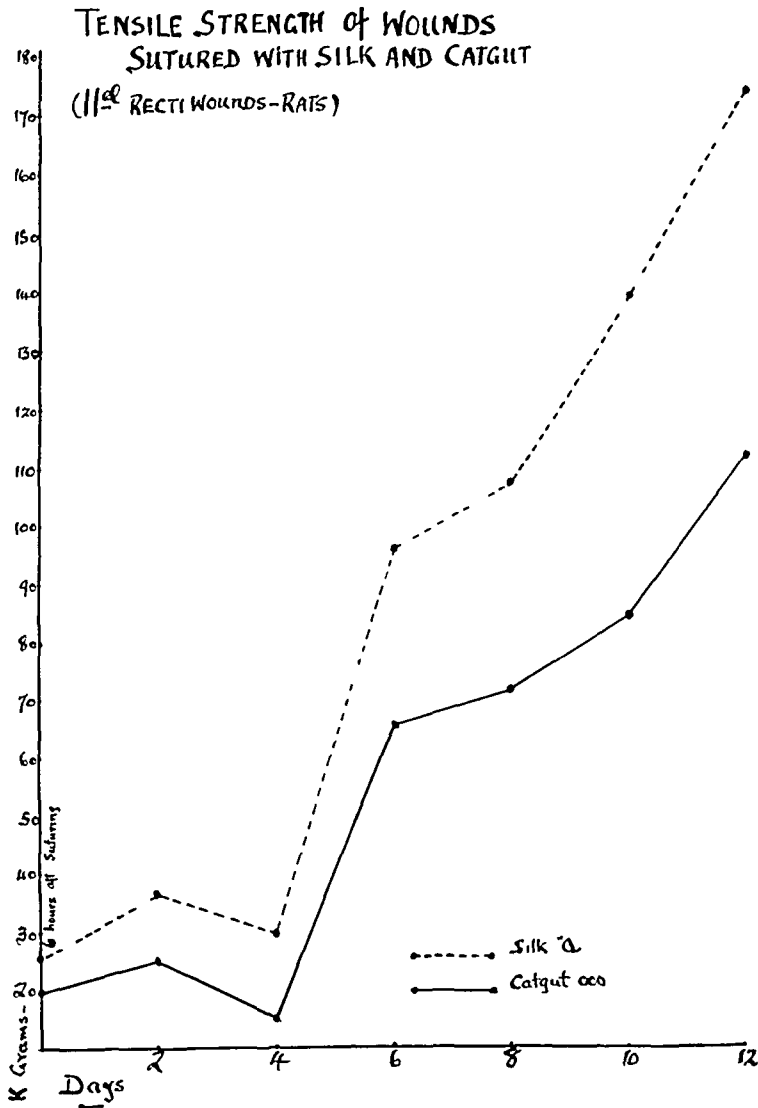


FIG 3—Graph representing the relative strength of parallel right rectus in cisions in rats sutured with silk and catgut

a corrected technic in my own cases, and later three of our staff began using silk technic in the thyroid and hernia work. Our next annual report showed such a marked improvement in our clean-wound healing that there was a general desire to use it on the part of the other surgeons. We have been careful to train the individual surgeon in its use before allowing him to adopt it as routine. The result is that we are satisfied that we are now having a much nearer approach to 100 per cent clean-wound healing and are convinced

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that our wounds are stronger and freer from later hernia formation than at any time when we were using catgut

We have compared wound healing in animals with parallel rectus incisions of the same length, using fine catgut suture material on one side, fine silk on the other. In this way we compared heavy and fine sutures of the same and different materials. At varying periods of healing we removed the portion of the abdominal wall containing the parallel healing wounds and applied traction at the two ends to test the tensile strength of the two sides. Invariably the finer sutures gave stronger wound healing, and fine silk was always superior to heavy or fine catgut in the tensile strength of the wound as a whole (Figs 2 and 3)

A study of the sections of these experimental wounds in different stages

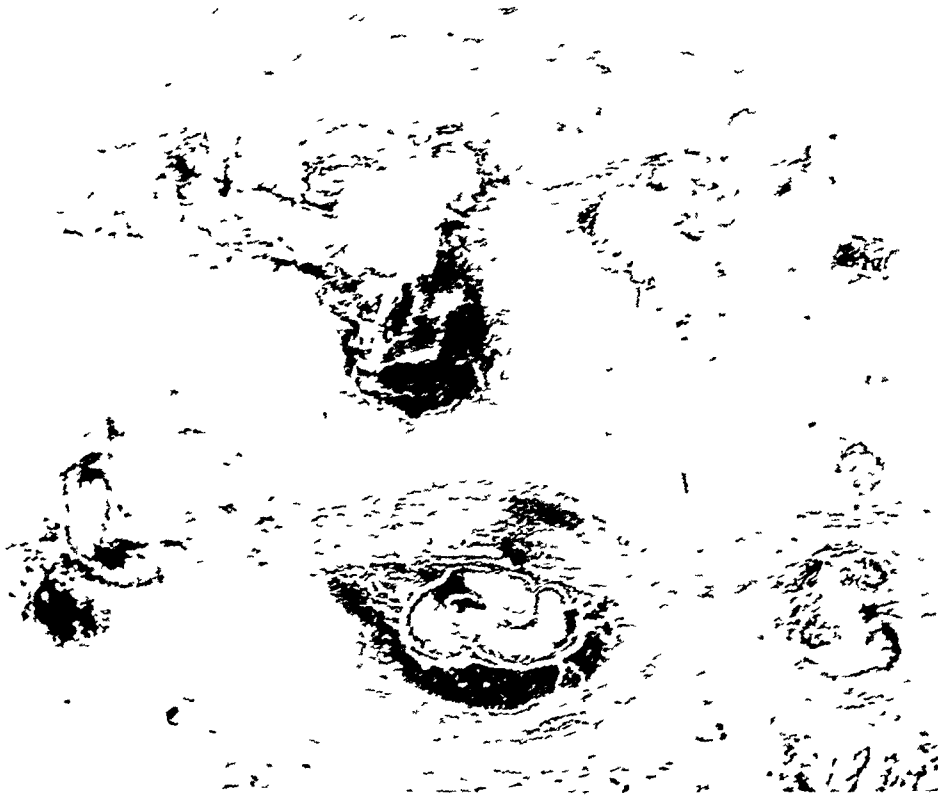


FIG. 4.—Section through rat's abdominal wall showing repair at the end of the second day. Compare tissue section about the catgut sutures on the left with the silk on the right

of healing is most illuminating in demonstrating certain reasons for the better healing with the use of fine silk as compared to fine catgut. Undoubtedly catgut, as it is introduced through the tissues, causes more trauma because a heavier needle is required, or if the same needle is used the angle of the catgut in the eye of the needle produces a larger hole in the tissue. In tying catgut, even when every effort is made to use no more force in setting the knots than when silk is used, as was true in the making of these experimental wounds, the resulting tension on the approximated tissues bordering the sutures is greater. Pressure necrosis is certainly greater in the sections studied as is shown by the zone of fluid and leucocytes around the catgut sutures as compared to the small zone or entire absence of it in the silk sutures (Figs 4 to 7)

Another striking feature in the sections is the far larger zone of leucocytes about the catgut than about the silk sutures. This would indicate a more



FIG. 5.—Section of rat's abdominal wall on the fourth day of repair after suture of parallel right rectus incisions. Catgut on the left, silk on the right.

irritative reaction of the tissues to catgut than to silk. In the later stages of healing, from the tenth day on, the catgut becomes absorbed, leaving a residual zone of leucocytes, whereas the fibres of the silk sutures become separated by

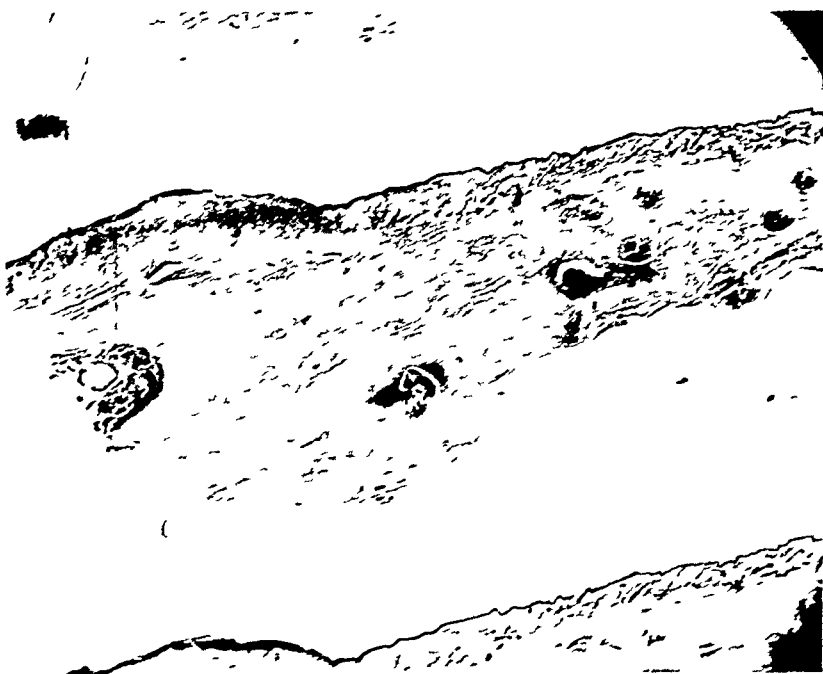


FIG. 6.—Section of rat's abdominal wall on the eighth day of repair after suture of parallel right rectus incisions. Catgut on the left, silk on the right.

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infiltrating foreign-body giant cells, with a minimum or absent zone of leucocytes (Figs 4 to 7.)

The tables showing wounds sutured both with catgut and with silk (Figs 8 and 9), offer an explanation for the more frequent wound infections, where these suture materials are used in combination. The dead spaces and the zone of leucocytes surrounding so many of the catgut sutures indicate low-grade infection. If non-absorbable foreign bodies, such as silk sutures, are in contact with or in close proximity to these areas of infection, a more active infection with a persistent sinus may result. Certainly in the clinical cases in our series where both catgut and silk were used, the incidence of clean-wound infection was greater than when either was used alone. Halsted



FIG. 7.—Section of rat's abdominal wall on the tenth day of repair after suture of parallel right rectus incisions. Note the almost complete disappearance of catgut and the separation of the figures of silk by infiltrating giant cells. Catgut on the left, silk on the right.

had noted this and made a categorical statement advising against using the combination, but did not offer an explanation for the poor results.

These experimental wounds will be described in greater detail by Dr Peter J. Vivier, who collaborated with the writer in this study. They corroborate the studies of wound healing and tensile strength of wounds with various suture materials published by Howes and Harvey<sup>3</sup> Howes, Sooy and Harvey<sup>4</sup> and more recently by Howes.<sup>5</sup> Many of their experiments were carried out in wounds of the stomach wall in rats where uniform conditions of manometric pressure to determine the bursting point of the wound could be maintained.

It is exceedingly interesting to watch an alert, thinking young surgeon as he develops technic and skill in the use of fine silk in his clean-wound repair. As he grasps the idea of minimum tension, minimum trauma to ligated tissue, minimum bleeding and careful knife dissection, he becomes



keenly interested and then enthusiastic over his improved results. Finally there appears a jealous care in improving his asepsis and gentleness with

*Comparison of Silk and Catgut 1930-32 in Thyroids, Hernias and Fracture Service*

T H Y R O I D S				H E R N I A S				F R A C T U R E			
Catgut	%	Silk	%	Catgut	%	Silk	%	Catgut	%	Silk	%
1930											
Total	35		154		84			58		0	
Trivial	1	3	2	1	11	13	negl- ible	3		-	
Serious	1	3	0	0	2	2		5		-	
1931											
Total	201				100		49		38		79
Trivial	2	1			4	4	0	0	5	13	0
Serious	2	1			1	1	0	0	2	5	0
1932											
Total	0		286		36		113		1		102
Trivial	-		1	0.4	2	6	2	2	3	2	4
Serious	-		2	0.7	0	0	1	1	2	5	1

FIG 8—Comparison of catgut and silk technic for three years in thyroids, hernias and fractures

tissues, and, when using catgut, an insistence upon much finer grades of catgut than those he had formerly considered essential to wound repair. I have yet

*Comparison of Catgut and Silk in the Repair of Clean Wounds*

	Catgut	%	Silk	%	Both	%
1930						
Total	158		159		8	
Trivial	20	13	3	2	2	25
Serious	4	3	1	1	0	0
1931						
Total	346		354		23	
Trivial	28	8	4	1	5	22
Serious	7	2	2	1	0	0
1932						
Total	306		656		19	
Trivial	24	8.2	10	1.5	1	5
Serious	4	1.3	6	0.9	1	5
Grand Total						
Total	810		1,169		50	
Trivial	72	8.9	17	1.5	8	16
Serious	15	1.9	8	0.7	1	2

FIG 9—Summary of wound repair for three years comparing the results with catgut with silk and with both in combination

to see a carefully trained, open-minded and thinking young surgeon who, having once acquired the silk technic, does not prefer it to catgut in the repair

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of clean wounds One of our surgeons who since has become convinced of the superiority of silk once said "I can't use such fine silk because it breaks constantly" Our reply was "Don't use silk as your regular technic unless it does break"

There is this to be said against the use of silk by some surgeons If they are overdeliberate and have any tendency to putter, the use of silk will accentuate these characteristics One sees occasionally a surgeon, brought up in the use of silk in clean wounds to the exclusion of all other suture material, who gets lost in the ritual of silk technic and loses sight of the main issue This Brahmin attitude is especially to be criticized in abdominal work, where prolonged operations are not tolerated as they are in the extremities or the brain But if this tendency to waste time is guarded against, I do not believe it is necessary to take more time with silk sutures and ligatures than with any other fine material Whatever the material, it should be used in the finest grades to get the best wound healing

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## ACUTE POST-OPERATIVE OBSTRUCTION OF THE BOWELS DIAGNOSED BY THE FLAT RONTGENOGRAM

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THE diagnosis of acute post-operative obstruction of the bowel is so greatly helped by the use of the flat rontgenogram that it seemed desirable that this method and its advantages be presented to the Surgical Association as part of this symposium. It is particularly desirable that the method have your approval, as one still sees intestinal and fecal vomiting given as the signs of acute bowel obstruction, in some recent magazines and books. These *are* signs of obstruction, just as cachexia is a sign of cancer. The great need today, in the conduct of any acute bowel obstruction, is a better understanding of the earliest criteria on which a diagnosis can be made. The death rate in other forms of acute bowel obstruction is no higher, perhaps is lower, than in those obstructions following operation, and this is true in spite of the fact that this latter form of obstruction develops in the hospital and under competent supervision.

Every abdominal surgeon would feel his work had had its greatest bugbear removed, were the problems of distention, its causes, difficulties and worries, eliminated from the post-operative course of his laparotomized patient. This never will be, as long as we are unable to control, at will, the natural processes of peritoneal healing. I will not point out the many articles citing statistics, nor will I repeat individual figures giving the percentages of cases in which acute obstruction of the bowels is a cause of emergency secondary operations. The figures are appalling, the condition a calamity. Instead, I will repeat some general statements frequently made. First, post-operative adhesions are the commonest cause of acute intestinal obstruction, excepting hernias. Second, in the patient presenting symptoms of acute abdominal distress, the finding of a laparotomy scar should raise at once in the physician's mind the possibility of adhesions as the cause of those symptoms. A further fact is that with each twenty-four hours of time elapsed from the onset of symptoms of acute post-operative bowel obstruction, the death rate mounts so rapidly that it is approximately 100 per cent at the end of ninety-six hours. Therefore, any harmless procedure that will add any detail of diagnosis or will advance the promptness of that diagnosis by even a few hours should be adopted universally.

I cannot speak for localities in which you each work, but of a few I have knowledge, and in these I know that many are not availing themselves of the aid so satisfactorily given by a flat picture of the abdomen under these conditions. Some text-book and magazine articles still do not mention the desirability of the rontgenogram in these cases of acute obstruction. I have

seen enough of the psychology of medical men perhaps have evaluated my own mental processes well enough to know that sometimes one may develop a "mental hazard," when standing by the bedside of a patient recently operated upon. The surgeon and the medical attendant have frequently had the pleasing experience of observing how the sick patient, with symptoms suggesting obstruction suddenly rights himself and avoids the tragedy of a secondary operation following close on the heels of a primary procedure. The trauma of operation makes difficult the proper evaluation of the post-operative symptoms and the early separation of the benign from the fatal. We have seen cases complaining of fullness in the epigastrium, of gagging, of gulping up a mouthful of clear or bile-tinged fluid, of slight distention, of nagging crampy pains at peristaltic intervals, with perhaps a slight elevation of pulse and temperature. On the one hand clear up or on the other go on to obstruction and death. We have worried, wanted and waited for some clinching bit of evidence. We have been inclined to procrastinate because we have known how great a shock it would be to the patient recently operated upon, and have felt the misgivings of the family when told that a second serious operation was under consideration. The combination of these facts leads to the development of the "mental hazard" and to the adoption of a course of least resistance and the decision watchfully to await developments another few hours. All this we have done in face of the fact that every surgeon academically states an acute obstruction case cannot be operated upon too soon. Under circumstances such as these to face the patient and his family requires no inconsiderable amount of moral courage. Tangible evidence is therefore desirable.

In the modern hospital the facilities of the X-ray department are such that the patient who is the source of worry to the surgeon, because of the slightest or earliest symptom suggesting obstruction, can be easily examined. The evidence for or against obstruction can be obtained without the patient or the family suspecting there is any anxiety in the mind of the doctor or knowing what is being done. That fear can be verified or eliminated in ten minutes' time without disturbing the patient even as much as in the routine of daily care. Preparation of the patient is not required. The procedure is simple and harmless. It is harmful to use an opaque meal to determine the patency of the bowel in the patient with these suspicious symptoms, for thereby very minor symptoms may become tragic major ones. A portable X-ray unit is rolled into the sick-room, the patient just sufficiently lifted to slip a plate-holder under his back and a picture snapped. Many writers advocate rolling the patient on his side to demonstrate better the fluid levels and distended loops or sitting him upright to visualize the fluid levels. The slides to be shown are of patients after operation taken in the patient's room with a portable machine. We have not found it necessary, for diagnosis, to add the discomfort or risk of an unusual change of position in these routine examinations. The knowledge gained is usually conclusive. It may be obtained within a few hours of the first untoward symptom. This may be twenty-four, forty-

eight, even seventy-two hours before the development of those usual textbook symptoms of obstruction that lead to an emergency laparotomy

Experimentally, in the mechanically obstructed dog<sup>4</sup> gas distention of the small bowel has been demonstrated in three hours, and in three and one-half hours in the obstructed large bowel. In this experimentally obstructed gut the fluid levels were demonstrable as signs of the obstruction some three and four hours later than the gas distention evidence. Other experimental injury causing paralytic ileus produced demonstrable gas in the bowel in five and one-half hours, and fluid levels some seventeen and one-half hours after the injury. These findings correspond to the opinion of clinical workers that evidence of mechanical obstruction is earlier shown than signs of paralysis.

Points of differential diagnosis between paralysis of the bowel and mechanical obstruction are being better understood, but they are not always to be separated. Well-developed intestinal paralysis generally is thought to be a hopeless finding, but at that period when the condition is that of a paresis rather than a paralysis, much may be accomplished. The signs are definite enough for the surgeon to attack the problem of an acute post-operative obstruction before distention is a disturbing factor and even before vomiting has actually taken place. He often early can relieve himself of the worry coincident with the care of a patient who is "misbehaving" even a little, and can assure the family that things are going to come out satisfactorily sooner than if this method is not a routine one. In these cases, energetic methods directed at bowel evacuation may be persisted in with hope of great accomplishment.

The great proportion of cases of post-operative obstruction represents the adherence of some one loop of the small bowel to another area. Rather infrequently does the post-operative obstruction develop as a result of kinking or adhesions of the large bowel alone. Therefore the finding of gas in the large bowel or in the cecal head, and none in the small bowel, makes the diagnosis of an obstruction improbable. The basic principle to be observed in the examination of the flat roentgenogram of the abdomen is that in the small bowel gas is not normally to be seen as it is intimately mixed with fluid, so in the post-operative patient, the finding of gas in the small bowel in a quantity larger than the occasional small bubble, is abnormal. There is some difference of opinion as to what is the earliest demonstrable sign in these obstruction cases. Ginzburg<sup>3</sup> recently said "the earliest sign is the showing of fluid levels in the bowel." It is our opinion that the evidence of gas in the small bowel, distending even one loop, is the earliest X-ray evidence. The film may show one or several loops of small bowel distended, with serrated, ribbed, feathered, or herring-bone shadows as they are spoken of by various observers. These are the first signs and represent the valvulae conniventes, or valves of Kerkring, and are closely placed in the small bowel. Late, the distended loop of small bowel loses these markings even though the condition was primarily mechanical. Their absence indicates a very grave prognosis in contrast to a fair or good prognosis where the evidence of muscular tone is shown by the

feathered shadows Gas in the small bowel is centrally placed in the abdomen in the incipient stages In a lateral view it is near the ventral surface Later the distended small bowel may crowd the collapsed enema-emptied large bowel aside and so fill the flanks

A little later than the "one loop" stage of gas in the small bowel, one finds the ladder pattern of Tieves, an observation known long before the use of the X-ray It seldom is seen clinically in the acutely obstructed abdomen but is definitely and routinely early seen by aid of the rontgenogram Gas in the small bowel is in well-defined small loops whose shadows are rather uniform Fluid in the small bowel, because of the small loops, produces short, vertical columns of fluid An important diagnostic symptom of gas under obstructive pressure in the small bowel, is the great increase in the calibre of the bowel gas shadow While an important sign in the making of a diagnosis, it may lead to some confusion, as these distended small bowel loops may equal the large in diameter

In infants, the above general rules for observation of gas in the small intestine have their exception as gas normally may be seen Nevertheless in these cases, if gas is seen in the small intestine and not in the large intestine, the probabilities are that an obstruction is present

In contradistinction to the absence of visible gas in the small intestine, gas is a normal finding in pictures of the large bowel and stomach Gas in the distended colon is peripherally placed on the film and there is no tendency to loop formation except of course in the sigmoid region The gas and fluid columns are longer and more vertical when the cæcum, the ascending colon, and the descending colon areas are visualized with the patient in an erect position The colon is further recognizable by its characteristic haustral markings, which are far more widely spaced than those of the small bowel The globules of gas normally present in the colon are larger than the abnormal globules in the small bowel

Combining the above general observations, the important points to be observed are that when gas is found in the small bowel it has diagnostic weight, and particularly so if there is little or no gas in the large bowel, the latter having been emptied by the enemas that usually have been given so energetically in these cases The opposite of this is that no gas in the small bowel and considerable distention of the large bowel indicates a case in which waiting is justifiable, and the further use of enemas and laxatives When a doubt exists as to the diagnosis, the picture can be repeated in six hours and the comparison of the pictures then should be conclusive as to the desirability of an operation

Differential diagnosis is most difficult between the acute mechanical post-operative obstruction and the post-operative paralytic ileus as seen by X-ray The difference is that paralytic ileus begins almost always as a high intestinal affair, often including the stomach, and not in the colon, so that in these cases the early gas distention is correspondingly higher The small bowel markings are early obliterated as the bowel has early maximally relaxed and dilated

To summarize,

First, the flat abdominal rontgenogram used in the post-operative case eliminates procrastination

Second, in the group of cases clinically very doubtful, it can be the diagnostic factor

Third, it offers something definite to show a family in explaining the need for a second operation

Fourth, it enables one to avoid an unnecessary exploration

Fifth, it is life-saving when obstruction is shown to be present before general distention and paralysis have developed

Sixth, the method usually will locate that part of the bowel in which the obstruction has developed, thus indicating the proper place for the secondary incision and a procedure in accordance with the location

Seventh, the findings have prognostic value

The films shown on the screen demonstrated, first, a very early acute mechanical obstruction and the stages of its progression with less and less "feathering" up to a complete absence of these markings in the late cases of mechanical obstruction. Second, the early great dilatation in the type with obstructive symptoms associated with peritonitis and paralysis. Third, the high small intestine and gastric dilatation in the paralytic ileus group.

The films shown, with but two exceptions, have been made by Dr Wm M Doughty, to whom I have been indebted for help and advice in the diagnosis of these unfortunate complications of abdominal surgery.

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DISCUSSION—DR DAVID CHEEVER (Boston, Mass) remarked that in all cases the cardinal symptoms of distention, obstipation, pain and vomiting must have been present which would make a diagnosis of acute intestinal obstruction highly plausible. The stomach could be evacuated by a tube, the colon could probably be emptied by an enema and what distention remained must be of the small intestines. Thus we would get the same information afforded by Doctor Palmer's X-rays.

He raised the query whether one should not try to avoid going to the laboratory for diagnoses which might have been obvious perhaps to the old-school surgeon.

DR ALTON OCHSNER (New Orleans, La) said the X-ray diagnosis of ileus undoubtedly has not been sufficiently appreciated by American surgeons. In order to determine the appearance time of gas and fluid in obstructed intestine, obstructions of

## RONTGEN DIAGNOSIS BOWEL OBSTRUCTION

various types were produced in animals. Obstructions were produced at various levels, some were of the simple variety whereas others were strangulated. They found positive rontgenographical findings earlier in strangulated obstruction than in simple obstruction. In an animal in which one hour previously a simple obstruction of the jejunum had been produced, an X-ray plate was obtained in the horizontal position (shown), whereas this was in the upright. Contrary to my previous belief based on clinical observations, gas occurred earlier than did fluid. I had formerly emphasized the importance of taking plates in the upright position in order that fluid levels might be visualized. Based upon this experimental work, however, I feel that the obtaining of a rontgenogram, as Doctor Palmer has suggested, in the horizontal position is all that is necessary because the earliest finding is gas. Doctor Ochsner presented a series of slides, one to show a fluid level in an animal one hour after the production of a simple obstruction, one to show the comparison between the horizontal and upright positions in the same animal three hours later, and one to show the difference between the simple and strangulated obstructions of the small gut. It is evident that the amount of gas and fluid present in the intestine is greater following a strangulated obstruction than following a simple obstruction. He thought, based upon this experimental work, that one is justified in saying that early in the presence of strangulation the X-ray is of value. One hour after a strangulated obstruction and three hours after simple obstruction there was rontgenographical evidence of obstruction. It is therefore of special value in those cases of strangulated obstruction, and it is, of course, the type of case in which early surgical intervention is especially indicated.

DR HAROLD BRUNN (San Francisco, Calif.) said that in the X-ray diagnosis of acute bowel obstruction as shown by the dilated loops of small bowel and fluid levels in the standing and lateral position, there were two possible sources of error. One has already been mentioned in the paper which is the occurrence of the same picture in an adynamic ileus resulting from some other conditions where operation may not be indicated, and secondly in any case of gangrene of the bowel which sometimes comes on very suddenly as the result of a band compressing the vessels of the mesentery. In such cases it is possible not to have the usual dilatation of the bowel above the point of obstruction, or of the gangrenous bowel itself. He had had such a case where the diagnosis of obstruction was eliminated because the X-ray plate did not show the usual picture. Doctor Robinson, of Santa Barbara, in a similar case of gangrene, where some twenty-four inches of bowel were involved, noted also at operation that the bowel above the obstruction was not dilated. Wangensteen, of Minnesota, has done some experimental work on animals along this line which verifies to a certain degree this fact. It seems well that we should make note of such an important factor as this.

DR JOHN J. MORTON (Rochester, N. Y.) said that if the surgeon carries a stethoscope around with him he can make a diagnosis before it is necessary to call in the X-ray. One can get very definite peristaltic sounds through the stethoscope.

Sometimes an early X-ray will show a loop of a bowel with gas in it and nobody be able to determine whether it is in the large or the small intestine. In such a case, if a very thin enema is given, one can outline the large bowel and determine definitely that the gas is in the small bowel loop.

Sometimes one has a dilated stomach in the presence of a high obstruction which overlies the distended bowel. In this instance if a stomach tube is passed and the stomach emptied one can sometimes demonstrate the dilated loop by X-ray.



# THE INTRAVENOUS ADMINISTRATION OF DEXTROSE IN RINGER'S SOLUTION

WITH PARTICULAR REFERENCE TO ITS USE IN ACUTE ABDOMINAL CONDITIONS

BY J. SHELTON HORSLEY, M.D.  
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ACUTE abdominal conditions occupy a prominent part in general surgical practice. They demand immediate therapy. They may be accompanied by shock and hæmorrhage with the prospects of a rapidly spreading inflammation. The differential diagnosis cannot always be accurately made. Delay in the treatment of a perforation of a hollow viscus or of intestinal obstruction is notoriously dangerous, and the mortality rate rises with delay.

Internal hæmorrhage may follow trauma with or without an abdominal wound. The differential diagnosis between shock and hæmorrhage is not always clear in the early stages. The concentration of the hæmoglobin and of the red blood-cells in shock without hæmorrhage is a very valuable laboratory sign. The fact, however, that early hæmorrhage may be combined with shock and the fall of the hæmoglobin may not be marked until the hæmorrhage has progressed rather extensively, is a source of some confusion. The danger of any operative procedure is greatly increased in the presence of shock, but in shock due to the sudden perforation of a viscus or to hæmorrhage, early operation may be imperative. It is under such circumstances that the prime consideration is the immediate maintenance of the blood-pressure by some measure that will not give late deleterious results.

In shock, whatever may be the theories as to its etiology, there is a loss of fluid from the vascular system. The endothelial lining of the smaller vessels and capillaries becomes more permeable than normal and the fluid plasma stagnates in the tissue spaces. This condition makes a lessened volume of fluid for the heart to propel, lowers the blood-pressure, and decreases the nutrition to the vital organs of the body, some of which, as the brain, are extremely susceptible to a diminution of normal nutritional processes. Low blood-pressure maintained for some time also profoundly affects the function of the kidneys and of the liver.

The introduction of fluids which do not readily exude from the vascular system but which contain foreign elements may serve the immediate demands of elevation of blood-pressure, but their later effects are sometimes disastrous. The remedy may be worse than the disease. I have had no personal experience with acacia preparations, which are occasionally lauded as being quite valuable. I have, however, used Hogan's<sup>3</sup> gelatin preparation. The immediate elevation of the blood-pressure and the apparent benefit to the patient were striking, but the three patients in whom it was injected eventually

died, with symptoms indicating uræmia. The gelatin preparation seems to occlude the small vessels in the kidneys. With that experience I have been unwilling to adopt for filling the vascular system preparations that would be retained but that were foreign and different in construction from what is normally found in the blood.

Matas,<sup>6</sup> in 1923, before the American Surgical Association, first presented his method of continuous intravenous injection of a 5 per cent dextrose solution. He reported striking results in several cases. We have adopted this principle he established, somewhat modifying the technic, and have added to the 5 per cent dextrose Ringer's solution, which contains sodium chloride, calcium chloride and potassium chloride. The beneficial action of sodium chloride, as in Ringer's solution, is obvious and has been demonstrated in a number of ways. The calcium chloride not only supplies the regular need for calcium, but the calcium salts stimulate the heart-beat and tend to make less permeable the endothelial cells of the capillaries, and thus to promote the retention in the vascular system of the solution that is placed in it. The potassium, while apparently not so important as the sodium or calcium, is an essential in the blood plasma and has an important part in the sequence of the stages of the heart-beat.

This combination of 5 per cent dextrose in Ringer's solution is what might be called an artificial blood serum. The dextrose is, to be sure, in larger percentage than is normally found in the blood, but it is isotonic with the blood, as Matas and others have shown. The sodium, calcium and potassium are in practically the same proportion as found in the blood plasma.

The introduction of this fluid intravenously in acute abdominal conditions is extremely helpful in many instances. If there is shock, and the systolic blood-pressure has dropped below 90, the solution may be rapidly run in, 500 cubic centimetres or more within a few minutes, until the systolic blood-pressure has been restored to within ten or twenty points of its normal level. It is obvious that under these conditions there can be no strain on the heart which suffers from lack of fluid to propel. Then the flow is reduced to 100 to 200 cubic centimetres an hour. In the meantime, if operation is indicated it can be done while the intravenous flow goes on, giving more fluid if it seems to be indicated by the blood-pressure, and decreasing it when the blood-pressure is maintained at a fairly satisfactory level.

If the abdominal condition is accompanied by marked hæmorrhage or if the blood-pressure is not satisfactorily maintained by the solution, a transfusion of blood can be given through the intravenous cannula while the administration of dextrose and Ringer's solution is temporarily discontinued.

If the operation involves repair of a hollow viscus, it would seem satisfactory therapy to afford the injured viscus physiological rest. As the function of the stomach and intestine is to digest, propel, and absorb food, these tissues may be put at rest for some time by using intravenous dextrose in Ringer's solution, for the electrolytes in the blood are supplied by the ele-

ments in the Ringer's solution, calories are furnished by the dextrose, and water, of course, is the medium in which the dextrose and electrolytes are held. Dextrose contains high caloric values, a gram of dextrose being equal to 3.75 calories. A 5 per cent dextrose solution given at the rate of about 200 cubic centimetres an hour for twenty-four hours will amount to 844 calories.

In cases of peritonitis or sepsis, or in dehydration, the continuous intravenous administration of this 5 per cent dextrose in Ringer's solution for several days is often beneficial. It must be borne in mind, however, that when the blood-pressure is about normal the heart may be unduly strained by giving the solution too rapidly. Usually the flow of about 150 cubic centimetres an hour can be easily absorbed, but in the old, or in patients with arteriosclerosis or high blood-pressure, sometimes even this amount will unduly raise the blood-pressure.

Another advantage in the intravenous dextrose and Ringer's solution is the protection of the liver, particularly in acute abdominal cases in which the operative procedure may be prolonged and the anæsthetic irritating.

Althausen,<sup>1</sup> of San Francisco, has recently shown that, while the presence of a certain amount of glycogen is essential for hepatic function, "in diseases of the liver, insufficient gluconeogenesis causes 'internal' carbohydrate starvation, which results in a reduction of hepatic glycogen, probably largely through depletion of that part of it which serves as a storage form of carbohydrate. Both in experimental animals with hepatic damage and in patients with diseases of the liver, it is possible by administration of suitable amounts of dextrose to relieve the internal shortage of carbohydrate and, as a result of this, to bring about glycogen storage. Dextrose therapy is indicated in all cases of primary and secondary hepatic disease."

According to Althausen, dextrose seems to have been first advocated for treatment of diseases of the liver by Beddard in 1908, while Opie and Alford and Graham, independently, demonstrated that the feeding of carbohydrates lessens the susceptibility of dogs and rats to necrosis of the liver by chloroform and by phosphorus. This observation has been confirmed by others. That most general anæsthetics have an irritating effect upon the liver as well as upon the kidneys is generally known. Chloroform, which is now but little used as an anæsthetic, may induce acute yellow atrophy of the liver. In such anæsthetics as avertin, which is absorbed by the portal system and goes directly to the liver, the concentration of the anæsthetic on the liver is obvious. A moderate impairment of hepatic function is rather difficult to ascertain, whereas renal function is more readily estimated.

In a series of dogs that were somewhat susceptible to nephritis, MacNider,<sup>2</sup> of the University of North Carolina, has tested various solutions that might act as a buffer for the kidneys and protect them from the effects of the anæsthetic. He says "The use of an isotonic solution of sodium chloride or of Ringer's solution in such animals rendered susceptible to an anæsthetic is of no value in protecting the kidney against the anæsthetic. These solutions are unable to influence the amount of stainable lipoid material in the kidney or to prevent an increase in its amount during a period of anæsthesia. When a 2 per cent solution of sodium bicarbonate in Ringer's solution or a 5 per cent solution of glucose in Ringer's solution is given pregnant animals and senile animals, they protect the kidney against the toxic action of ether and to a less extent from a similar action from chloroform. This protection is associated with the ability of such solutions to either cause the disappearance of the stainable lipoid material in the kidney or to so change it chemically that it fails to stain in its usual manner."

## INTRAVENOUS DEXTROSE IN ACUTE ABDOMINAL CONDITIONS

In a personal communication he says he thinks it is probable that there may be somewhat the same protective effect upon the liver as upon the kidneys

Attention has been called to the protection of the liver by a dextrose solution. In emergency cases the accurate study of the functions of the kidneys and of the liver is frequently impossible. To adopt a procedure or to give an anæsthetic that may seriously damage already diseased liver or kidneys is in some instances, merely postponing a catastrophe. In addition to meeting the requirements of the immediate treatment of shock or hæmorrhage, it is also necessary that consideration be given to the delayed effect of the emergency and its treatment upon the kidneys and the liver.

The excellent work of Orr and Haden<sup>2</sup> has shown the remarkably beneficial results of the intravenous injection of sodium chloride in obstruction of the upper gastro-intestinal tract, which is a frequent cause of acute abdominal conditions. They have demonstrated that sodium chloride is far more effective in raising the blood chlorides than any other chloride. In such cases an additional amount of sodium chloride may be readily added to this solution though in obstruction of the lower ileum or colon this additional chloride of sodium is not always necessary, though it is a marked peristaltic stimulant. Of course the definite need for additional sodium chloride must be determined by a blood analysis, though when a patient who is frequently vomiting gives evidence of high obstruction it is well to assume that there is a chloride deficit and to add an additional amount of sodium chloride to the dextrose and Ringer's solution as it is flowing.

The correction of acidosis and the promotion of the function of the kidneys when uræmia seems pending is also greatly aided by this solution. In markedly impaired kidney function the dextrose solution may be increased to 10 per cent and the salts eliminated. It is unwise, however, to adopt a hypertonic dextrose solution for an indefinite administration unless there is some special indication, as œdema. The hypertonic solution, while it carries more calories, is irritating to the vein and the more concentrated solutions of dextrose probably have some hemolytic effect upon the blood. Certainly it is simulating the natural methods of introducing nutrition to give it in small amounts continuously, unless there is an acute emergency such as œdema of the lungs or brain, when a highly concentrated solution of dextrose is quickly given.

The method that we have adopted for the continuous intravenous administration of dextrose and Ringer's solution is as follows.

We use a buret 54 centimetres long in which 100 cubic centimetres of fluid are contained in 9.2 centimetres of the length of the buret. The rate of flow is regulated by a screw clamp from 75 cubic centimetres an hour to as much as it may be necessary to give quickly, as in shock. In this way the danger of the entrance of air into the vein is largely obviated, while a constant rate of flow is maintained.

The rubber tubing should be boiled, stretched and twisted or beaten before

and after being boiled, and sterile water run through it, in order to remove deposits that may cause a reaction. New rubber tubing is boiled for an hour in a strong solution of soda, rinsed in running water and then boiled for an hour in tap water. At the end of the tube is a small connecting tip or metal adapter (nipple) which fits into the hypodermic needle of a Luer syringe. A glass tube is inserted near the end of the rubber tube.

All glass used in preparing the solution is Pyrex, and new glass is thoroughly washed before using.

To the 5 per cent isotonic solution of dextrose of Matas, we add Ringer's solution. Distilled water not more than twenty-four hours old is used in the preparation of the solution. Doubly or triply distilled water seems unnecessary. The usual laboratory still is satisfactory. (We use a Stokes copper-lined still.) The reactions after the intravenous administration of dextrose in Ringer's solution we find are due to other things than the lack of a meticulous preparation of the distilled water. Deposits in the rubber tube, a residue of water in the apparatus after sterilizing, impurities in the dextrose, too rapid flow of the solution in patients with approximately normal blood-pressure, are the chief causes of reactions.

The dextrose sold in bulk is unsatisfactory for intravenous use. While marked "chemically pure quality," an inspection of the analysis will show the presence of dextrin, traces of iron and other impurities. The dextrose in solution in ampoules is better. We have had prepared by one of the large pharmaceutical houses an ampoule of 100 cubic centimetres capacity containing a solution of such concentration that when added to 400 cubic centimetres of freshly distilled water a solution of 5 per cent dextrose and normal Ringer's solution is made, and is ready for immediate intravenous use. This is a simple, convenient and effective method.

After two or three days the vein becomes tender, and usually by that time the patient has had a sufficient amount of the solution for immediate needs. It is best, then, after two or three days, to remove the intravenous cannula and give the patient a rest for a day, when another vein may be utilized if necessary. In patients with large, accessible veins, and when the indications for giving the solution are for a period of not more than ten or twelve hours, a hypodermic needle is satisfactory for the intravenous administration. For this we use a No. 20 gage, stainless steel needle,  $1\frac{1}{2}$  inches (37 centimetres) long.

Dr Guy W. Horsley<sup>4</sup> and I have devised a cannula which is employed when the solution is to be given for more than ten or twelve hours. This cannula measures 5.6 centimetres in length and has at its tip an oblique opening that permits it to be introduced into the vein as easily as a grooved director. Its lumen is large and clear throughout, which lessens the chances of its becoming occluded. The base of the cannula is ground to fit an ordinary Luer syringe, so by merely disconnecting the metal adapter or nipple on the tube through which the intravenous solution flows the cannula is at once available for transfusion of blood by the syringe method. After the trans-

fusion the adapter may again be inserted into the cannula, and the flow of the dextrose and Ringer's solution can be continued

It is important to sterilize the apparatus in an autoclave because if sterilized in water some of the water may cling to the apparatus and produce a chill

In the January, 1931, number of the Archives of Surgery we published a description of this technic in which we stated that we had used it in about 750 cases with very few reactions. Since that time the reactions have been even more infrequent. During the past year, in our cases there has been no reaction due to the intravenous administration of 5 per cent dextrose in Ringer's solution

The apparatus is simple and avoids even the complication of the so-called "drip." The "drip" method is fraught with danger. There is the possibility of the introduction of air by the "drip" method which would be of no consequence in proctoclysis but would carry great danger in the vein.

The temperature at which the solution is given is of little consequence, provided it is not too hot. If it enters the vein at a temperature much over what would be the normal blood temperature, deleterious effects are likely to occur. The careless administration of a very hot solution would be followed by marked hemolysis and probably disastrous results. On the contrary, the solution at a degree considerably below the normal blood temperature, if given slowly has but little if any bad effect. Elaborate apparatus to keep the solution at a stated temperature is unnecessary, and it is extremely difficult to calculate the temperature at which the fluid enters the vein when it has to pass through a long tube and the cannula at varying rates of speed. The solution should never be poured into the buret at a higher temperature than 100°. Hanging a few hot-water bottles around the buret, or placing a hot-water bottle over the tube near the cannula is all that is necessary and even this may be omitted.

Gage, Ochsner and Cutting<sup>7</sup> have shown the beneficial effect on intestinal peristalsis of insulin in dextrose solution. Their experiments seem to indicate that the intravenous injection of dextrose in 10 per cent solution tends to inhibit peristalsis, but when insulin is given along with the dextrose peristalsis is stimulated. We think it is best as a routine to give insulin with the solution. We give with 5 per cent dextrose eight to ten units of insulin for every 500 cubic centimetres of the dextrose in Ringer's solution, the insulin being injected into the rubber tube while the solution is flowing. This is enough to take care of some of the dextrose, and the additional insulin excreted by the pancreas will suffice for the remaining portion. It is rare, however, to find sugar in the urine after giving 5 per cent dextrose in Ringer's solution even when as much as 200 cubic centimetres an hour are given for more than twenty-four hours.

The objection has been raised to the use of intravenous dextrose that it calls for the secretion of an excessive amount of insulin by the pancreas, and that when the solution is discontinued this excessive secretion will produce a

hypoglycæmia Such a condition, however, can be easily corrected in the usual way by the oral administration of dextrose in orange juice and by other measures

In the emergencies in which spinal anæsthesia is to be used, the intravenous dextrose in Ringer's solution is very helpful It arrests the fall of the blood-pressure, to a large extent, by increasing the flow of the solution In such cases the intravenous cannula is more satisfactory In emergencies in which it is necessary to run in the solution rapidly, the introduction of an intravenous cannula is better practice, though a needle may be used

*Summary*—The advantages of the continuous intravenous administration of a 5 per cent solution of dextrose and Ringer's solution in emergency cases are, that the 5 per cent solution is isotonic, that the dextrose with the electrolytes carries most of the valuable non-protein constituents of the plasma of the blood, that there is no foreign material in it, that it may rapidly fill up the vascular system and raise the blood-pressure immediately if not permanently, that it protects the liver and kidneys, and that it not only relieves dehydration and supplies the electrolytes, but provides calories

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## SUBCUTANEOUS INJURIES OF THE ABDOMEN

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PAPERS have appeared from time to time during the past several years which have dealt with subcutaneous injuries of the abdominal viscera and penetrating wounds of the abdomen. During the period from 1885 to 1890 the mortality of subcutaneous injuries of the abdomen was from 60 to 70 per cent. By 1900, the mortality in this type of case had been reduced 30 per cent. Demel published a paper from Eiselsberg's clinic in 1925, which covered a period of twenty-three and one-half years, during which time 126 cases had been observed. The mortality in this series was 21.9 per cent.

The character of the force causing subcutaneous injury or injuries is extremely variable and it may be applied in a number of different ways. Some have emphasized especially the importance of the way in which the force is applied in affecting different viscera. Force applied to a circumscribed area is more apt to injure the intestine or kidney, while force which is applied more diffusely over a wide area is more apt to injure the liver, spleen, pancreas or blood-vessels. Some viscera are protected because of their anatomical position. Engorgement during physiological activity may predispose to injury, also pathological changes in the organ to which the force is applied indirectly. The viscera of the young and those which have plasticity are not as frequently injured as are those of the old, or those which, because of fixity, cannot change form or location when the force is applied.

The mortality has been reduced in the subcutaneous injuries because the possibility of involvement of the solid viscera or intestines and bladder has been so emphasized that caution is always exercised, and with increasing experience the surgeon has improved in diagnostic ability. Exploratory laparotomy is much more frequently resorted to than before, and, as a result, many injuries are recognized and repaired which formerly would have terminated fatally because of hæmorrhage or peritonitis.

In the series about to be reported there are 140 cases of subcutaneous injuries of the abdomen. Forty-five of these cases have not been analyzed, as they were treated expectantly and the injury of the abdominal viscus was not demonstrated. All of these patients had symptoms of intra-abdominal injury which were marked and serious enough to warrant hospitalization.

*Injuries of the Liver* —In this series are twenty cases of rupture of the liver. An operation was performed on fourteen of the twenty and six of these died, giving a mortality of 40 per cent. Four patients were not operated on because of many complicating injuries. The mortality, then, in the twenty verified cases of rupture of the liver was 50 per cent.



How extensive the injuries may be is indicated by the history of one of the cases admitted to the hospital in the early 'nineties. The patient was a forty-nine-year-old Negro who was unconscious when brought to the hospital after having been run over by a cart. The pulse was 110 and feeble, the temperature was 95.6° F. Judging from physical findings, some of the ribs on the right side were fractured. The patient soon regained consciousness, but complained of thirst, became extremely restless and the extremities were cold. The patient died seven hours after admission, not having recovered sufficiently from shock to justify any operative procedure. The autopsy revealed a rupture of the right lobe of the liver and right kidney, intra-peritoneal hæmorrhage and fat embolism of the lungs.

The histories of two cases of rupture of the liver with associated injuries follow.

*CASE I*—D. T., a white male, aged thirty-four, fell into the hold of a vessel, a distance of twenty-five feet, about two hours before admission. Both femurs were fractured at the middle third, but no other injuries were discovered. The lower extremities were dressed in extension and the patient seemed fairly comfortable. The next day the temperature rose to 101.8°, pulse 120. The patient complained of severe pain in the left side. He became delirious, the temperature and pulse rose rapidly, reaching 108.8° and 170 at the time of death six days after admission. The autopsy revealed fractures of both femurs, rupture of the liver and hæmorrhage into the pleural and peritoneal cavities.

*CASE II*—A. G., a white girl, aged nine years, was struck by an automobile, and when brought to the hospital was in acute distress. She complained of pain in the abdomen and left arm. The pulse was as high as 130 and almost imperceptible. Generalized abdominal tenderness, most marked in the right upper quadrant, was noted. The left humerus was fractured.

A laparotomy was performed two hours after the injury. A large laceration was found in the dome of the liver. This laceration was packed with gauze and some sutures inserted. The child recovered rapidly and completely, although some consolidation of the lung was noted and there was a pleural effusion.

The mortality of rupture of the liver is greatly increased, as may be seen by associated injuries. Edler collected 189 subcutaneous injuries of the liver and found that the mortality was 85.8 per cent when there were associated injuries. In rupture, unassociated with other injuries, the mortality was 78.2 per cent.

The diagnosis of rupture of the liver cannot be made with certainty. A provisional diagnosis can be made when there are symptoms of internal hæmorrhage, when there are localized tenderness and rigidity in the right upper quadrant, and when the force applied has been such that rupture might be suspected. Falls from a height, the patient striking upon the feet, not infrequently cause rupture of the liver. We have not noticed bradycardia, which Finsterer regarded as a rather characteristic symptom, neither have we noted pain radiating to the right shoulder.

In all the cases the capsule of the liver was torn. The "sub-capsular rupture" with destruction of liver parenchyma described by Brandberg has not been encountered.

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The treatment has consisted of packing with gauze combined with suture when sutures alone would not suffice. Gutta-percha has also been used as a diaphragm to facilitate the escape of bile from the surface of the laceration.

The prognosis in the uncomplicated cases depends upon the early diagnosis and early control of the hemorrhage. It is somewhat surprising that the uncomplicated cases in some statistics have a higher mortality than the complicated, for the patients are brought to the hospital later, when the injury to the abdominal wall, unassociated with other injuries, seems slight.

*Rupture of the Spleen*—In 1928 Connors read a paper before this society in which he summarized the studies of thirty-nine cases of splenic injury. It included all injuries of the spleen encountered in the Harlem Hospital during a twenty-three-year period (1905 to 1927, inclusive). The injury was demonstrated at autopsy or by operation. In this paper it is pointed out that in the period (1906 to 1916) there were twelve admissions to the hospital for ruptured spleen and of these twelve only three were due to automobile accidents, while in the subsequent eleven-year period (1917 to 1927) there were twenty admissions for splenic rupture and fourteen of these twenty cases were the result of such an injury.

The following cases will be cited to indicate the mechanism of rupture and the symptoms.

CASE III—This boy, aged twelve, was standing at a corner when an automobile passed. The driver leaned out of the window and slapped the boy over the left upper abdomen. The boy doubled up with pain. That night he became pale, perspired freely, suffered from abdominal pain and vomited. He was brought to the hospital thirty hours after the injury. The temperature was 100°, pulse 130, blood-pressure 110/70 and haemoglobin 60 per cent. He complained of pain in the left upper quadrant of the abdomen, which was somewhat distended. The abdomen was generally tender but the rigidity was most marked over the left half and dullness could be made out in the iliac fossa. Repeated blood counts revealed a falling cell and haemoglobin count. Because of the symptoms and the character of the injury a diagnosis of ruptured spleen was made. The abdomen was opened through a high left, pararectal incision. A fragmented spleen was removed and the patient recovered rapidly.

CASE IV—E. J., a colored man, aged twenty-three, was struck in the lower left back by a brick about one-half hour before admission to the hospital. He experienced severe upper left quadrant pain. The temperature was 100.4° F., pulse 92, haemoglobin 80 per cent, white blood-cells 19,250 and blood-pressure 150/88. Extreme tenderness was noted over the entire abdomen, most marked in the left upper quadrant. An operation was performed and a ruptured spleen removed.

Another mechanism of rupture is illustrated by the following case.

CASE V—T. W., a colored male, twenty-nine years of age, fell three stories, striking on a concrete pavement. When brought to the hospital the temperature was 101° F., pulse 82, respirations as high as 48, blood-pressure 115/70. There were no signs suggesting injury of the brain or cord. Pain in the abdomen increased while the patient was being observed, as did the rigidity. The symptoms as they developed pointed to a rupture of the spleen. When the laparotomy was performed a rupture of the spleen was found. A splenectomy was performed. Pneumonia developed and the patient died on the fourth day. An autopsy was performed. There were no peritoneal changes.

Extensive bronchopneumonia was found. A number of ribs on the left side had been fractured.

During the past few years several papers dealing with rupture of the spleen have appeared. The prognosis depends upon the severity of associated injuries and the time at which the operation is performed. Early diagnosis, as in most surgical emergencies, is of prime importance.

The principal symptoms are those of shock and hæmorrhage. It is often difficult to determine whether the patient is suffering from shock or hæmorrhage. Operations undertaken while the patient is in severe shock will increase the mortality, and, on the other hand, operation should not be delayed until so much bleeding has occurred that the chances of recovery are greatly reduced.

All patients complain of abdominal pain. This, in by far the greater number of cases, is in the left hypochondrium. It may, however, be generalized. Abdominal distention occurs in most of the cases. In our experience the most important points are the history of the accident, pain in the left hypochondrium, abdominal rigidity, dullness in left iliac fossa, increase in the pulse rate and a falling cell and hæmoglobin count. In suspected cases a blood count should be made on admission and repeated at frequent intervals. Other symptoms have been described, such as pain in the left shoulder, and vomiting, and considerable importance has been attached to them. These are not infrequently incidental, and undue significance should not be attached to them. In some instances the case may be regarded as that of an acute abdomen, and the rupture of the spleen is found when the abdomen is opened.

Surgical judgment must be exercised as to when an operation is to be performed. In the badly shocked case a fatal outcome may follow a poorly timed operation. Pool has pointed out that in some cases there is a distinct latent period between the subsidence of the symptoms of shock and the beginning of the symptoms of internal hæmorrhage. The operative risk will be reduced if this is kept in mind and the operation is performed in the interim (the latent period).

We much prefer removal of the spleen to suture of the rent, which is impossible in many cases, and to tamponade, which may be followed by secondary hæmorrhage. In most cases, splenectomy is as simple as either of the other procedures. The physiology is not altered and the patient, if he survives the operation, makes a complete recovery.

Spinal anæsthesia is advocated by some. We have used a combination of gas and ether anæsthesia.

There are seventeen instances of ruptured spleen in this series, fourteen of which were operated upon. Four of the fourteen patients died, giving a mortality of 28 per cent. The four deaths occurred in patients with multiple injuries. One had a ruptured lung, one a rupture of the kidney, laceration of the colon and fractured ribs, one a fractured skull, fractured femur and fat embolism, and another died on the fourth day of bronchopneumonia.

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This patient also had several fractured ribs. The associated injuries were the cause of death in these cases.

The diagnosis must be made early, but considerable surgical judgment must be used in determining when the operation should be undertaken.

*Injuries of the Intestines*—The intestines are not infrequently involved in subcutaneous injuries of the abdomen. The small intestine is more frequently injured than the large and the stomach less frequently than the large intestine. Wyss, in his paper, deals with thirty-nine injuries of the gastrointestinal tract. The duodenum was involved in five cases, other segments of the small intestine in thirty-two and the large intestine in two cases. The force is usually circumscribed and the patient gives a history of being kicked, struck by a stone or run over by an automobile. A bursting rupture is also occasionally seen. The intestinal loop may be ruptured from within by its contents of liquid and air. A bursting rupture of this kind is usually long, extending over a considerable segment.

As a rule, an initial shock follows the application of the force. Not infrequently, however, the patient walks into the hospital and clinically shows no evidence of impending danger. The possibility of rupture of the intestine must be kept in mind when circumscribed blunt force is applied to the abdomen, and the patient should be hospitalized. Within a short while, we have seen a patient die who refused hospitalization. This patient, an elderly man, was kicked in the abdomen one morning by his son-in-law. He was a Pole and understood English with difficulty. Many attempts were made to hospitalize this man, but he refused to enter. The next morning he was brought to the hospital, a spreading peritonitis having developed. He died shortly after an operation was performed. All suspected cases should be hospitalized. There are eleven cases of rupture of the small intestine. Eight of these were operated upon and five died, giving a mortality of 62 per cent. One case that recovered was operated upon within three hours and another within twelve. A perforation of the ileum was found in the third, but a local abscess had formed which was drained.

Petry reports 199 cases with a mortality of 87.5 per cent, Hertle 138 cases with a mortality of 76.8 per cent, Wyss thirty-nine cases with a mortality of 33.3 per cent. Just reports eleven cases of rupture of the small intestine from Ranzi's clinic (Innsbruck) with but one death, a mortality of 9.99 per cent. These figures are the best yet given. Seven cases were operated upon within six hours with one death, two cases in from seven to twelve hours with no deaths, two within from thirteen to twenty-four hours with no deaths. All were ruptures of the small intestine without associated injuries.

A provisional diagnosis may be made by the history and usual clinical signs and symptoms. The X-ray assumes a rôle of unusual importance in these cases, for when free air is demonstrated in the peritoneal cavity there is no doubt as to the procedure to be followed. Exploratory laparotomies are

not infrequently performed. If recovery occurs, there are few, if any, sequelæ—these may be post-operative hernia and stenosis of the bowel.

*Rupture of the Kidney*—In the records of the hospital there are found thirty subcutaneous injuries of the kidneys. In twenty-one cases a diagnosis of an injury of the kidney was made because of the local signs and blood in the urine.

The following cases may be cited:

CASE VI—J. H., white male, age not given, was struck by a train six hours before admission to the hospital. When he entered the hospital the temperature was 98° F, pulse 65 and a tender mass could be palpated in the left flank. He was carefully watched. There was no aggravation of symptoms noted on admission. The hæmaturia decreased rapidly in amount. The patient was discharged three days after admission against advice.

CASE VII—L. S., white male, aged fifty-one years, slipped and fell heavily against a plank, striking his left flank. Within twenty minutes he passed a large quantity of smoky urine. His pulse on admission to the hospital was 56, temperature 97.8°. There were no signs or symptoms of increasing hæmorrhage, although marked dullness was found in the left flank. Red blood-cells were found in the urine for several days, but the patient rapidly recovered.

The following is the record of a patient who sustained a subcutaneous rupture of the kidney. In this instance an operation was deemed advisable.

CASE VIII—P. R., colored girl, thirteen years of age, fell down some cellar stairs, striking the right side of the abdomen. She had difficulty in getting to her feet and ascending the stairs. Severe pain developed in the right flank. When brought to the hospital twelve hours after the accident the temperature was 102.4° F, pulse 120, respirations 28, blood-pressure 95/50. Tenderness was elicited by deep palpation over the right side of the abdomen. The tenderness was, however, most marked over the region of the right kidney posteriorly. The urine consisted almost of pure blood.

At operation the right kidney was exposed. A transverse tear through the middle was found. The tear was closed by suture and a drain placed down to the kidney bed. The patient recovered rapidly after suture of the tear.

Two deaths occurred in the twenty-one cases of contusion of the kidney. In these two cases there were associated injuries. An injury of the kidney was predicated upon the local findings and hæmaturia.

Nine patients were operated upon. Three deaths occurred among the nine—a mortality of 33 per cent. Different operative procedures were employed, such as suture of the tear, nephrectomy, packing and placing of a clamp on the pedicle of the kidney. The last procedure was employed once in the early days of the hospital. The patient had sustained a severe injury with a dislocation of one hip. The patient's condition did not improve. A continuing hæmorrhage from the kidney was suspected and the simplest procedure was employed to control it.

Injuries of the kidney should be treated conservatively unless there are increasing signs of hæmorrhage. Twenty-one out of thirty occurring in this series were so treated with a mortality of 9 per cent. It has already been mentioned that the concomitant extensive injuries in two cases were probably the cause of death.

*Rupture of the Bladder*—Only eleven cases of perforation and rupture

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of the bladder have been observed. Among the eleven cases are but two in which the rupture was hydrostatic.

CASE IX—C. B., colored male, twenty-two years of age, was knocked down while fighting twenty-four hours before admission to the hospital. He had been drinking freely. On admission to the hospital he complained of abdominal pain and passed bloody urine. The temperature was 96° F., the pulse 96, white blood-cells 22,000. The abdomen was greatly distended and marked tenderness, especially to the right of the umbilicus, was noted. Muscular rigidity was also marked. Shifting dullness could also be made out in the lower part of the abdomen. Eighteen hundred cubic centimetres of bloody urine were withdrawn by catheter. An immediate operation was performed. Bloody urine was found in the peritoneal cavity, which was walled off on the right side. A rent six centimetres in length was found in the bladder on the peritoneal side. This extended somewhat into the anterior wall of the bladder. The rent in the bladder wall was sutured and a catheter placed in the space of Retzius for drainage. Patient recovered.

In one case no operation was performed.

CASE X—A colored male, aged fifty, was brought to the hospital August 25, 1903. He was brought by the police and was said to have been overcome by heat. He had stopped work in the fields four days before. The patient was unable to void and suffered severe abdominal pain. On admission the abdomen was of board-like rigidity. The patient died forty-eight hours after admission. At autopsy an intraperitoneal rupture of the bladder was found.

The cases of extraperitoneal rupture were frequently associated with fractures of the pelvis, and the treatment consisted either of suture of the tear and drainage, or simply drainage of the space of Retzius.

The immediate symptoms of intraperitoneal rupture may vary. Lewis has seen a patient walk into the receiving ward twenty-four hours after having been kicked in the abdomen while in a drinking bout. This patient had no shock and not enough abdominal symptoms to arouse any great suspicion. In another instance the patient was in a railroad wreck. The wreck occurred in the morning at about five o'clock when the patient's bladder was full. He said that when the collision occurred he experienced a slight jolt and was rolled out of his berth. Strangury developed soon and he experienced severe pain in the abdomen. When he was brought to the hospital six hours later, he appeared shocked. Marked rigidity was noted over the lower abdomen and there was marked tenderness. The patient was catheterized and blood-stained urine withdrawn. An immediate operation was performed and a longitudinal rent, extending from the apex to the base of the bladder, was found on the peritoneal surface. Considerable urine was found in the free peritoneal cavity. The rent was sutured, and the patient made an uneventful recovery.

The history is of great importance in making a diagnosis of injury of the bladder. With the modern methods of cystoscopy the diagnosis should be made in a high percentage of cases, but unfortunately these methods do not always give us all the information we desire. Strangury, blood in the urine, lower abdominal pain and rigidity are symptoms of greatest significance. In

some instances an exploratory incision is indicated and should be advised. With refinements in diagnosis, the mortality of subcutaneous and perforating wounds of the abdomen have been gradually, but consistently, reduced.

Early recognition of the probable nature of the lesion and early use of the surgical therapeutic procedure to correct the lesion will be followed by reduction in the mortality. There is an irreducible minimum, however, and this is due to the associated or complicating injuries.

DISCUSSION.—DR I RIDGEWAY TRIMBLE remarked that there is one interesting operative procedure, one that is erroneously thought to be life-saving in many cases, that should possibly be mentioned. In subcutaneous injuries in which great hæmorrhage is incurred through rupture of the liver or spleen, not infrequently blood is collected, filtered, and reinfused into the vein of the patient. Thus, Allen reported a patient with a ruptured liver who was reinfused with 800 cubic centimetres of his own blood recovered from the abdominal cavity, and who died fifty-six hours later with complete anuria.

The answer to this unfortunate result may lie in the damage done by the toxins elaborated by a ruptured liver in which autolysis takes place so rapidly. Helwig reported a patient with traumatic pulpefaction of the liver who died eleven days later with jaundice, extensive nephrosis, diffuse hæmorrhages in the serous cavities, with a greatly increased blood nitrogen content, especially the creatinine. The reinfusion of a patient's own blood is often fraught with great danger.

DR JAMES M. MASON (Birmingham, Alabama) said that he lived in a section of the country where, on account of the large colored population and for other reasons perhaps, they are forced to deal with a large number of these cases. He had been surprised to find there was a mortality in the Johns Hopkins Hospital of around 30 or 35 per cent in them.

He said the average mortality for that class in the country, as Doctor Lewis said, is between 50 and 60 per cent. In 1923, he attended 127 cases with a mortality of 58.8 per cent and in 1930 Moyer reported 202 cases in Cincinnati, with 50.8 per cent. In 1931, Billings and Walkling, from Philadelphia, had 156 cases with 55.14 per cent. In 1931, he assembled twenty cases with 55.5 per cent mortality. In the past year there had been operated on for supposedly penetrating wounds of the abdomen in Hillman Hospital in Birmingham sixty cases with a mortality of 50 per cent, thirty recovered and thirty died.

Operations were done on eleven with non-penetrating wounds (and they had forty-nine cases for that year) with twenty-eight deaths and a mortality of 57.14 per cent.

These collected cases were not done by any individual surgeon but were from the hospital and visiting and resident staff in the hospitals. As compared with this 50 to 60 per cent mortality in 1931, B. C. Willard reported sixty-three individual cases with a mortality of 35 per cent. He said that compared very favorably with the mortality which Doctor Lewis had just reported for Johns Hopkins Hospital.

He called attention especially to the influence of hæmorrhage in this 50 per cent mortality. In the 127 cases that he reported in 1923, he subdivided them into penetrating wounds with extensive visceral injury with minimum hæmorrhage. He found in the parallel cases they had forty-seven cases with large hæmorrhage and forty-one deaths, a mortality of 87.2 per cent. Of the penetrating injuries with small hæmorrhage, forty-seven cases, there were seventeen deaths, a mortality of 36.1 per cent.

As to irreducible mortality he said there is room for improvement to take place in the item of mortality due to hæmorrhage. He considered from what he had read and what he had gathered, particularly from some questionnaires he sent out to 100 of the best offices in the country, that the question of blood replacement is not receiving the important consideration that it should receive for this type of case.

A sociological question comes in here. Most of these penetrating wounds of the

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abdomen occur in people in the lowest strata of society and are either the results of brawls and fights among people of that class, or encounters with officers of the law. They are, as a rule, treated not in our more especially organized and better operated hospitals, but in the large charity hospitals of our cities and counties. Blood replacement in these cases to be most successful must be applied not the day after the patient is operated on, nor two or three days later, but immediately, at the time, to receive just the same consideration at the hands of the surgeons as the laparotomy.

He said we all learned about the curability of gunshot wounds in the days of Doctor Fogelbaum. We know that we can prevent peritonitis if we operate promptly and control hæmorrhage. One can reclaim a certain number of cases that would die from hæmorrhage. In that day we did not know about blood replacement and we did not consider it in its proper light.

Blood for transfusion to be of benefit to this class of patients must be obtainable at the same time they come in for the operation, before the laparotomy. The only way that city and charity hospitals can be organized for furnishing this blood is to consider blood as a therapeutic agent of highly specialized type for which there is a definite demand and for which the hospital ought to be prepared to pay, just like it is for elaborate hospital equipment and elaborate X-ray, expensive and elaborate sera and anti-toxin and things like that. Whenever we can establish our charity hospitals and our big public institutions and things of that sort where they recognize that a certain amount of blood ought to be used at a definite time on this particular class of patients, then we can reduce in a large measure this difference between  $87\frac{1}{2}$  per cent mortality where hæmorrhage carries them out, to about 35 per cent in those cases where they die from complications and things of that sort. He looked forward confidently to the time when all hospital boards will recognize this and supply this blood. In reply to a questionnaire of 101 hospitals in this country, less than 40 per cent said that they included in their regular expense the question of supplying blood for transfusions for indigent patients.

DR LE GRAND GUERRY (Columbia, S. C.) remarked, in discussing the paper of Doctor Lewis, that some years ago he published in the *ANNALS OF SURGERY*, a paper of "Twenty-seven Cases of Penetrating Gunshot Wounds of the Abdomen with Three Deaths." He was more convinced now than ever before that a number of these cases were saved by taking the necessary time to improve the patient's condition before operating.

Specifically as regards the problem of hæmorrhage, one must remember that in the presence of traumatic shock it takes comparatively little loss of blood to produce a profound circulatory disturbance. He said often they have had this experience, in cases of perforating wounds of the abdomen with hæmorrhage, they have operated on and repaired ten or twelve perforations, practically emptied the abdomen of blood, and completed the operation without finding the source of the hæmorrhage. An irregular tear in a small vessel coupled with a profound drop in blood-pressure permits thrombosis of the vessels, thereby controlling the hæmorrhage before the operation is undertaken. This is one of the main reasons why we never operate with precipitate haste.

We believe it to be a great mistake to take these patients with penetrating, perforating bullet wounds of the abdomen that come in in a condition of profound shock, with or without hæmorrhage, rush them to the operating room and operate immediately. If one does so one is inviting disaster and an excessively high mortality.

He had collaborated on this thought in the text of his paper by pointing out that one has immediate soiling in perforated wounds of the abdomen but not a true peritonitis. It takes time to develop a spreading peritonitis—several hours of time—and this time can be well spent in making the patient a safer surgical risk.

There are those, however, who disregard the above-mentioned principles which he believed to be fundamental not only in relation to bullet wounds of the abdomen, but as applied to the broader field of acute abdominal emergencies. However, when these



principles are so disregarded the proponents will continue to come to the forum of surgical practice in America and talk about 40 per cent and 50 per cent mortality

DR WILLIAM L ESTES (Bethlehem, Pa ) said there is one feature of Doctor Lewis' paper that he would like very much to emphasize, and that is the effect of non-penetrating wounds of the abdomen He said that most wounds that we have seen have had lacerations and have shown their injury He had, however, had the experience of seeing quite a number of others, in which nothing visible was evident externally to indicate that there had been any serious injury within the abdomen Yet because of long shock and weakness and other evidences it was apparent there had been a very serious intra-abdominal injury

Among the other injuries of the intra-abdominal viscera which he had had occasion to see were lacerations of the greater omentum

He had distinctly in mind a man who was thrown forward, struck on the edge of a projecting bolt, which made a wound penetrating only the skin and the superficial fascia That man apparently had such a trifling injury that he was kept at home for a while *Not improving, he was sent to the hospital, evidently in a serious condition* of exhaustion and with evidences of some sort of intra-abdominal effusion He was operated on and it was found that his greater omentum had been torn and that he had been bleeding seriously from the omentum for over twenty-four hours Doctor Estes said "seriously"—at first it was serious, and then it clotted and finally the clots were being absorbed by the escaping sera

Another intra-abdominal laceration is a rare condition which he had seen, and that was a laceration of the upper edge of the mesentery In one case this was torn so that the vessels were opened and the individual was bleeding profusely It resulted from a precipitation forward by moving machinery, the man striking in spread-eagle fashion on the floor He was brought in with the tear in the upper part of the mesentery from which he was bleeding profusely

The fourth rare injury which he had seen was laceration of the jejunum just distal to the duodenojejunal fold, just beyond the membrane, where a part is held firmly and the rest has considerable excursion in the abdomen These fixed points where an intestine, especially the small intestine, is held and the rest of it is mobile, are vulnerable points The effect of being thrown forward or being violently propelled forward on the abdomen, with the concussion and sliding pressure, may cause a laceration of the jejunum

In the case he had in mind he found a transverse laceration, involving almost half of the periphery of the gut

He was glad to hear that Doctor Lewis' statistics do not indicate that lacerations of the kidney should have operation invariably He had for many years given up operating on lacerations of the kidney unless there was a very large hæmatoma Unquestionably the results were far better by expectant treatment

DR M L HARRIS (Chicago, Ill ) said he wished to mention that the injury to the abdomen may not be a severe one in order to cause serious injury to the viscera

Recently a young man was brought into the hospital He was strong and healthy, eighteen years of age He had been riding a motorcycle He had a collision with a truck He did not injure the abdomen at all He came into the hospital and all he complained of were slight bruises on his leg

Doctor Harris happened to be in the hospital shortly afterward and examined the patient very thoroughly He seemed perfectly well There was no tenderness or pain in the abdomen, and the patient complained of none There was no soreness of any kind His condition was practically perfect

The patient was simply put to bed Within a few hours his condition was absolutely alarming and he died shortly afterward At the autopsy they found that the

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jejunum had been torn completely in two. There was no great hæmorrhage. The patient said when he entered the hospital that he didn't hit the abdomen at all in his accident, and he had no recollection of the abdomen being injured in any way.

Another case showing the effect of hydraulic pressure in a full bladder was that of a young lady, aged eighteen, who had been to a dance and therefore had a full bladder, was riding home late in the morning—or maybe early in the morning—in an automobile which had a collision. She was injured, and brought to the hospital. When he saw the patient she was in extreme collapse with evidence of great hæmorrhage. He transfused her immediately, opened the abdomen which was filled with urine and blood and found that the bladder had been completely torn from the urethra. The bladder was repaired, hæmorrhage stopped, and the patient recovered.

These cases show that slight injuries to the abdomen may occasionally cause severe injury to the viscera.

DR ARTHUR DIAN BEVAN (Chicago, Ill.) reminded the members of the American Surgical Association that the American Surgical Association had been very intimately associated with the development of this subject. One of the early pieces of surgical research published by Samuel D. Gross was on intestinal wounds. In 1884, he wrote a final paper on that subject.

In 1884, Charles T. Parkes, of Chicago, a member of this Association, did a series of experiments on forty dogs. He anæsthetized them. Then they were prepared aseptically for operation. The abdomen was shot through and the injury done immediately repaired. It is interesting to know that at that time he did this work, it was the first series of experiments on gunshot wounds that had been done on animals with the combined benefit of anæsthesia and asepsis. About half of the dogs recovered. Parkes reported this work in the Chairman's Address of the Surgical Section of the American Medical Association.

Parkes' work was immediately followed, in this country and abroad, by a number of reports of successful operations for penetrating wounds. Bull, in New York, reported one, Hamilton in Washington, Murphy in Chicago each reported successful cases, and it was really the beginning of the modern operative treatment for penetrating wounds of the abdomen.

There were other members of the Association who contributed much to this field of surgery, notably Nicholas Senn with his hydrogen-gas test and bone plates, and John B. Murphy with the Murphy button.

DR FREDERICK C. HERRICK (Cleveland, Ohio) remarked that it has been well said delay in acute appendicitis and intestinal obstruction is fatal. However, delay in some types of abdominal trauma is life saving, if the time is spent in overcoming shock by infusions, morphine, warmth, *etc.* and preparing the patient for better resistance to the surgical procedure. However, if hæmorrhage is evidenced, the quicker the operation the better. He had many times observed that severe hæmorrhage when seen during its occurrence or soon after is characterized by a progressively slow pulse, even as low as 56 or 58, occurring before an accommodative increased rate is established, a slow pulse is usually the first sign of hæmorrhage.

Rupture or a perforating wound of the liver is not usually followed by dangerous hæmorrhage, and he said they have been treating them by shock measures and tightly strapping the lower right chest. In such cases, a hæmatoma, sometimes of a large size may form beneath the diaphragm after which it can be aspirated or drained if necessary. As an exception to the rule, he reported a case of a boy of ten to twelve years of age who, falling from a height upon a fence, suffered an almost complete pulpifying of the liver. The patient was not operated on but treated as above. He died from hæmorrhage. Operation would certainly have been of no avail when one saw at autopsy the extent of the damage to the liver.

More amenable to surgery in his experience has been that of serious injuries to the

spleen Being a more vascular organ, hæmorrhage from it flows along the left colic trough, fills the pelvis, and, following serious trauma of the spleen, forms a definite diagnosis of splenic rupture and indication for a splenectomy As to the intestine, incomplete lacerations resulting from a jarring fall have especially interested him A girl of thirteen years sat down heavily on the sidewalk while skating and experienced a little pain in the right iliac fossa but continued her usual activities Ten days later a mass developed in the right fossa which on exploration proved to be an abscess following rupture of the peritoneal coat of the cæcum and ulceration through of the mucous membranes Naturally, such occurrences are most common near a fixed point of the small gut which becomes the point of tearing from the trauma These points are the second portion of the duodenum, the duodenojejunal juncture, the iliocecal juncture, and we must remember that the ascending and descending colon are greatly variable in the length of their mesentery, being practically sessile in one-third of the cases so that at any one of these five points a peritoneal tear may occur by blunt trauma or crushing trauma and later a completion of the injury by rupture through of the mucosa may occur

To him there has not seemed such great difficulty in diagnosing rupture of the bladder Take alcoholism with likely a full bladder and muscular relaxation, now add trauma in the shape of a suprapubic blow and rupture is likely A few hours later muscular rigidity, rising white blood count, abdominal tenderness plus an occasional X-ray for pneumoperitoneum have helped to diagnose these cases The introduction of air into the bladder seems a good procedure but he had not tried it He had persistently opposed cystoscopy in these cases, since it had always seemed to him that he would be washing the bladder through into the peritoneal cavity or into the pericystic space

Bullet wounds of the abdomen have offered some interest, especially with the slow moving bullets from the poor pistols available to many Many times he had determined that a bullet had not entered the abdomen by the following procedure, with the entrance wound as a centre, eccentric pressure is made in circles around the wound beginning perhaps two to three centimetres away from it This circle will cross the track if the bullet was reflected in the abdominal wall and tenderness is felt, the next circle, two or three centimetres farther out as these circles are successively made, a bullet track which has passed through the tissue is easily mapped out, showing that the bullet was reflected and not directly penetrated A most interesting gunshot case was that of a fleshy Italian who sat in a taxi-cab and leaned forward, when he was shot, to grasp his assailant When seen on the operating table, the bullet wound entered about opposite the navel on the left side, and four other wounds appeared in a direct line down the abdomen to about the middle of the left thigh The police and friends were certain that there had been five shots It did not seem possible that they could be all in a straight line It was easily found that a probe passed from one to two through the fat, and from three to four through the fat, and the final wound entered the thigh In explanation, as the victim leaned forward to grasp his assailant he wrinkled up the folds of his abdominal wall and the wound penetrated two of these folds, emerging between them The man's abdomen was not opened and of course a good result followed

DR JOHN H GIBBON (Philadelphia, Pa) said the most outstanding feature of this discussion has been the difference in the mortality rates generally reported and that reported by Doctor Guerry

It recalled to his mind a meeting of this Association in this city a great many years ago when John B Murphy, of Chicago, reported forty consecutive cases of perforative peritonitis with one death which left us all agape and ashamed of ourselves Nobody knew what to say

When Ransohoff of Cincinnati asked Doctor Murphy how many of these cases were more than twenty-four hours old when he operated upon them, Murphy, in closing the discussion said that there wasn't a medical man in Chicago who dared send him a case that was more than twenty-four hours old

## SUBCUTANEOUS INJURIES OF THE ABDOMEN

Doctor Gibbon did not think, however, that any such explanation can be applied to this difference in mortality because he thought there was a great deal in what Doctor Guerry had to say

During the War, in Belgium, at a British clearing station he was struck with the fact that the mortality in major operations was very much higher among the British soldiers than it was among the German prisoners. A great many of the British surgeons used to say, "You cannot kill these Germans"

It didn't take one long to realize why there was this big difference in mortality. It was just this, that the British soldier naturally was operated upon first, was given the precedence when it came to treatment and a prisoner lay abed and was treated for shock and when his turn came he was in better shape and there was a striking difference in the mortality

But, there is another aspect of this. A great many of them died of peritonitis or of gas gangrene, who never came to the operating table

In the question of gunshot and stab wounds of the abdomen, one of the most difficult and one of the most important things is the question of hæmorrhage. If you wait with the hæmorrhage cases, if you transfuse them, you are going to lose any number of cases that will not be included when it comes to estimating your operative mortality

There is not such a great difference in the operative skill of the members of this Association to account for the difference between 10 to 50 per cent. Therefore, it has to be accounted for in some other way

He thought Doctor Guerry was right when he says if one can just differentiate shock from hæmorrhage, and wait in the case that isn't bleeding the mortality will be very much lower than if one jumps in and operates upon them all at once

If there is one commentary that can be made, he thought, on surgery, it was the mistake of calling things emergencies that are not emergencies at all

DEAN D LEWIS said he didn't want to give the impression that we get nervous in the presence of gunshot wounds, because we tried to exercise a little judgment, too. But sometimes judgment is a little hard to exercise. When you are waiting and seeing a man getting a little worse all the time and there are progressive signs and symptoms, and you are trying to decide whether this man has shock or hæmorrhage, he was going to take chances on hæmorrhage

He also found out that the best way to control the symptoms arising from hæmorrhage is to ligate the bleeding point. You can do all the transfusions and everything possible, if that man is bleeding he is going to keep on bleeding until you ligate

There is another thing, he thinks Doctor Guerry's patient who was shot in the swamp ought to be very thankful to Providence that he had an open abdomen. He thought prolapse of the intestines had a lot to do with saving him, and feared much more the perforating wounds than the wide open wounds

Another thing, he thought all statistics showed that the gunshot wounds that are operated on earliest are the ones with the highest percentage of recovery. Whenever he sees a gunshot wound and can operate he operates and does not take any chance on what is going on in the abdomen

# ACUTE INTESTINAL OBSTRUCTION IN THE NEGRO

REVIEW OF 347 CASES

BY FRANK K. BOLAND, M.D.

OF ATLANTA, GA.

FROM THE DEPARTMENT OF SURGERY OF EMORY UNIVERSITY

THERE is no subject in surgery which inspires the forceful language and scintillating aphorisms as does a discussion of acute intestinal obstruction. Usually the situation is so dramatic and the need for prompt action is so urgent that the treatment advocated sounds like a "call to arms." No military leader, in exhorting his hosts to go forth to battle, could use more appealing arguments than have been invoked by many gifted members of the profession for immediate surgical intervention in this catastrophe. It would be presumptuous and useless to attempt to match the eloquence which has been brought into play. The object of the present paper is to give facts concerning the incidence of the disease in the Negro race, its causes and results, in support of the principles of treatment which never cease to ring in our ears.

Without a previous complete survey the impression has existed that acute obstruction is especially common among colored people, and that the results of treatment are particularly bad. Lacking scientific investigation it was thought that on account of the tendency of the Negro to keloid formation, that adhesions and obstructive bands would be more likely to develop in the peritoneum, following trauma and inflammation. No evidence has been adduced, however, to show that there is anything in the tissues or fluids in Negroes which would make them more susceptible to the growth of peritoneal bands and adhesions.

This study reveals the fact that in the Grady Hospital, Atlanta, acute intestinal obstruction is more than twice as prevalent in colored patients as compared with white patients. During the past ten years, 1923-1932, there were 154 cases of acute obstruction among 50,000 white patients admitted to the hospital, and 347 cases among the same number of Negro patients admitted. Sixty-four white patients and 159 colored patients had strangulated hernia. This difference in the incidence of hernia obviously is due to the more strenuous manual labor done by the black man. The percentage of hernias becoming strangulated is about the same in the two races.

Among 347 Negro patients with acute intestinal obstruction 203 were male and 144 were female, the males predominating by reason of the larger number of strangulated hernias. Otherwise females would predominate, due to operations for pelvic disorders. The death rate in the sexes was remarkably constant, being 30 per cent in males, 33 per cent in females, an average mortality of 31 per cent. Strangulated hernia, as is usual, was the most

## ACUTE INTESTINAL OBSTRUCTION IN NEGROES

frequent cause of obstruction, 46 per cent, and furnished the lowest mortality, 19 per cent. The total mortality, excluding hernia, was 41 per cent.

The death rate by years also was fairly constant, being as follows:

	Cases	Deaths	Mortality Rate
1923	5	2	40 per cent
1924	35	10	28 per cent
1925	31	10	32 per cent
1926	42	16	38 per cent
1927	23	6	26 per cent
1928	41	14	34 per cent
1929	26	7	27 per cent
1930	48	17	35 per cent
1931	56	15	26 per cent
1932	40	11	27 per cent
Total	347	108	31 per cent

All fatalities were attributed to the direct results of intestinal obstruction except three deaths from heart disease, three from pneumonia, and one from cerebral hemorrhage.

The relation of the duration of the obstruction to the result was as follows:

	Number of Patients			Mortality Rate
	Total	Recovered	Died	
Admitted not more than six hours after obstruction	31	28	3	10 per cent
Admitted between six and twelve hours after obstruction	18	16	2	11 per cent
Admitted between twelve and twenty-four hours after obstruction	91	83	8	8.8 per cent
Admitted second day of obstruction	74	43	31	42 per cent
Admitted third day of obstruction	28	15	13	46 per cent
Admitted fourth day of obstruction	25	11	14	56 per cent
Admitted fifth day of obstruction	10	6	4	40 per cent
Admitted sixth day of obstruction	7	3	4	57 per cent
Admitted seventh day of obstruction	10	6	4	40 per cent
Admitted more than seven days after obstruction	33	18	15	45 per cent

These figures demonstrate graphically the enormous importance of immediate operative treatment. Nearly all these patients were operated upon from one to three hours after admission. While preparations were going forward for the operation, as a rule opportunity was taken for gastric lavage and the administration of saline and glucose by hypodermoclysis. As the majority of patients entered the hospital with unmistakable signs of complete obstruction few enemata were tried before operation. Often too much precious time had already been devoted to this treatment, although the Negro does not believe in the enema. He believes in salts. The Röntgen-ray was not used in diagnosis.

The mortality rate in 140 cases subjected to laparotomy within the first twenty-four hours was 10 per cent. Then the hour of grace was passed, and

the rate arose tremendously, being 52 per cent in seventy-four patients operated upon during the second twenty-four hours. From this period on the number of hours and days elapsing before operation did not affect the outcome materially, inasmuch as the mortality for all patients admitted after the first day was 46 per cent. No doubt the duration of the illness of some of these Negroes is not stated correctly in every instance, since such people are not always clear in their recollection of time. Nevertheless, there is no question but that they had acute intestinal obstruction, as disclosed by the operative findings, which often also demonstrated how long the condition had been present. Autopsies were done in five cases.

While the treatment of intestinal obstruction by strong cathartic medicines, generally self-administered, is not as detrimental as it is in acute appendicitis, the violent peristalsis induced by huge doses of salts and "black draught" augments the swelling and œdema at the site of obstruction, and probably sometimes causes a partial obstruction to become complete. Almost without exception these patients had taken one or more large purgative doses every day after they became sick.

*Post-operative obstruction*—Cases of post-operative obstruction, twenty, recovered, nine, died, eleven (two had no second operation). All post-operative obstructions followed operations for acute appendicitis and female pelvic diseases except two for inguinal hernia, one for perforated duodenal ulcer, and one for gunshot wound.

The mortality in patients subjected to operation for post-operative obstruction was 55 per cent. There were twenty such cases, with eleven deaths. In only two or three instances was it possible to show that the obstruction was produced by failure to properly peritonealize all raw surfaces. Formerly this mechanical defect was assigned as a common etiological element. Post-operative obstruction may be caused by rough and careless manipulation of abdominal viscera, and over-exposure, but apparently most cases are due to inflammation and infection which existed prior to the first operation. Perhaps if a second surgeon were called upon to treat the complication he would operate earlier than the surgeon who did the first laparotomy. It is only human for one to be reluctant to admit that it is necessary to reopen the abdomen only a few days after the patient has undergone one serious laparotomy, and the surgeon who performed the original operation is prone to persist in conservative measures too long.

Inhalation anæsthesia was the rule. In fifty-eight patients local anæsthesia was used. Spinal anæsthesia was employed sixty-four times, with fourteen deaths, but the anæsthetic was blamed with none of them. Spinal anæsthesia seems to be losing popularity. Why, is not clear. Few bad results are reported. Certainly it furnishes almost unbelievable abdominal relaxation, but ether still maintains its place as a safe and satisfactory anæsthetic. Avertin was not tried in any of these cases.

Sixteen cases diagnosed as intestinal obstruction recovered without operation, eight died without operation. Five cases were diagnosed as adynamic,

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or paralytic ileus One of these had enterostomy, and recovered, and one had enterostomy, and died Three died without operation Hypertonic saline and Ringer's solution were not tried in paralytic ileus in this series They have proved a valuable asset in private practice

### *Strangulated Hernia*

Number of Cases, 159 (46 Per Cent of Total)

	Total	Recovered	Died	Mortality Rate
Inguinal	136	115	21	15 per cent
Femoral	6	3	3	
Ventral	8	8		
Umbilical	7	2	5	
Duodenal	2	1	1	
Total			30	19 per cent

Ten cases had resection, three recovered Five cases had enterostomy, none recovered

### *Operations Causing Obstruction*

	Number of Cases	Died	Mortality Rate
Appendicectomy	36 (10 per cent of total)	14	39 per cent
Salpingo-oöphorectomy	24 ( 7 per cent of total)	8	33 per cent
Hysterectomy	18 ( 5 per cent of total)	8	44 per cent
Pelvic operation, nature not stated	11	3	
Adhesions following undescribed operation	11	3	
Undiagnosed tumor	2	2	
Cause unknown	31	14	
Total cause unknown	55 (16 per cent of total)		38 per cent
Perforated peptic ulcer	6	1	
Cholecystectomy	1	0	
Suprapubic cystotomy	1	1	
Cæsarean section	1	1	

### *Other Causes of Obstruction*

	Number of Cases	Died	Mortality Rate
Intussusception	11 (3 per cent of total)	7	63 per cent
Gunshot wound	10	4	
Cancer of colon	4	3	
Trauma	3	2	
Volvulus	3	2	
Meckel's diverticulum	2	1	
Tuberculous peritonitis	2	1	
Stricture of rectum	2 (Recovered)		
Mesenteric cyst	1 (Recovered)		
Retroverted uterus	1 (Recovered)		
Pneumococcus peritonitis	1 (Died)		



The largest group of cases of obstruction developing months and years after previous laparotomy was in appendicitis, being 10 per cent of the total. During the past ten years there has been a decrease in the number of cases of obstruction following laparotomy for pyosalpingitis, as there has been a decrease in operations for this disease. It is estimated that the number of operations has fallen off 75 per cent in the past decade. This interesting revolution in surgery in Negro females is ascribed by the gynecologists to milk injections. Either this treatment relieves the patient's symptoms to such an extent that she does not return later for operation, or else the inflammatory lesions are improved so much that operation can be done with less trauma, so that subsequent intestinal obstruction is not so apt to ensue. Sterilized skim-milk, freshly prepared, is the best substance for non-specific foreign-protein therapy, five cubic centimetres being given the first dose, and ten cubic centimetres every week for ten weeks following. Reactions are negligible. No doubt many of the cases of obstruction in this series recorded as due to former pelvic operations, or to adhesions, cause unknown, started with pyosalpingitis. Perhaps some of the other cases marked cause unknown had their genesis in so-called "idiopathic peritonitis," a convenient term.

Four adults had intussusception, two of whom recovered following operation. Two of these cases were caused by lipomata in the wall of the small intestine. Cancer of the colon gives a small incidence in this series. Study of surgical diseases of the digestive system in the two races has shown that peptic ulcer, diseases of the biliary tract, appendicitis and carcinoma occur only one-fourth as often in Negroes as in whites.

#### *Operative Treatment*

	Number of Cases	Died	Mortality Rate
Adhesions and bands released	72	17	23 per cent
Enterostomy alone (colostomy 2)	50	37	74 per cent
Enterostomy and releasing adhesions combined	13	6	
Resections	22	16	73 per cent
Lateral anastomosis only	1	0	
Reduction and repair of hernia	150		
No operation, or none recorded	39		

No jejunostomy was performed. Obviously the group of patients treated by enterostomy alone was desperately ill, and the less operative manipulation they had the better. Enterostomy should not be charged with the 74 per cent mortality, although enterostomy has not afforded the satisfactory results in obstruction which were predicted for it. The procedure is of little avail in paralytic ileus, in which only a short segment of gut can be drained. It seems that the success of the operation depends upon the completeness of the obstruction. The tighter a pyloric ring, the better a gastrojejunostomy drains. Pressure is necessary for drainage.

The treatment of acute intestinal obstruction has varied but slightly during the past ten years, and likewise the results. Before and after opera-

tion adjunct methods, instituted to combat what we understand to be the causes of death in obstruction, have been applied diligently and intelligently. These include lavage, both with the stomach and duodenal tube, and the free administration of fluids, carbohydrates and chlorides, by different means. Without these agents the termination of intestinal obstruction would be even more discouraging than it is. To the monumental work of students and experimenters in demonstrating the value of water, salt and sugar in such conditions, we are profoundly indebted. Even when these accessories do not save life, they prolong the days of many victims of obstruction, and make their suffering more endurable.

In half the cases the path of delayed operation in acute intestinal obstruction leads to the grave, despite the kindly aid which may be handed out along the way. The duration of the obstruction before relieved by operation still remains the principal factor in prognosis. It is a well-nigh hopeless task to educate some classes of patients to seek surgical aid promptly in such cases. Even some of the profession need lessons. In the meantime every precaution should be taken against the occurrence of many forms of obstruction, by insisting upon earlier operative treatment in abdominal lesions, and by thorough, careful surgery, and sometimes less surgery.

DISCUSSION—DR HUBERT A. ROYSTER (Raleigh, North Carolina) said that since he resided south of the Mason and Dixon Line, and since for thirty years he had had more or less all the work of a colored hospital of 125 beds, he might be permitted to give his impressions of Doctor Boland's paper.

As a general proposition, the Negro patient does not easily get into surgical shock, but once he is in it is difficult for him to get out. That is to say, he will stand very much more up to a certain point and then after that he slumps. This may be due to the types of diseases treated, or to a poor psychological attitude. The Negro patient rarely has, in Doctor Royster's experience, acute gaseous distention following operations.

Most of the obstructions they have had occurring post-operatively in the hospital, in the matter of four or five days afterward, have been due to bands of adhesions in the pelvis or in the region of the appendix. When Doctor Boland speaks of being able always properly to peritonealize these pelvic cases or even the appendix cases, he probably means only relatively, because most of the pelvic surgery which comes to the operating table on Negro women will give you no chance for flaps or peritoneal covering, as a rule, and a knuckle of gut getting down will very often adhere.

These adhesions are more easily formed and more definitely formed in Negro women because of the very tendency mentioned by Doctor Boland for the formation of fibrinous collections.

Most of the cases, of course, admitted into the hospital after former operations, come in very late. If they get results—and his have been about parallel with Doctor Boland's—it is only because there is a saving grace which prevents these patients from going very much farther.

Many years ago he reported a long series of cases of acute appendicitis in Negroes, less perhaps than that in the white, but they are getting more now.

DR WILLIAM D. HAGGARD (Nashville, Tenn.) referred to a discussion on the subject of intestinal obstruction before the British Medical Association, when a report was given in which 3,064 cases were collected from London hospitals in the four-year period 1920-1924. Each of the causative factors of obstruction was set forth. The one

causing the largest mortality was intestinal obstruction by gall-stones, which amounted to 50 per cent

He had had four such cases three of whom recovered The unsuccessful case was that of a short, fleshy woman There was a big gall-bladder full of stones He removed the gall-bladder At the conclusion of the operation, the segment of intestine that had the stone popped up into the incision, which obliged him to open it after having superimposed an operation of great magnitude at an inappropriate time As a consequence, he lost the patient

The total mortality in this group of 3,064 cases was 26.56 per cent It was diluted somewhat, of course, by the herniæ which carried the lowest mortality

The next highest mortality was due to intestinal obstruction from carcinoma, which was 43.5 per cent

The thing that struck him most in that discussion was a report on intussusception that occurred in the practice of Sir William Taylor of Dublin, recently deceased, where he said that he had had a personal experience in his own family that was very disastrous It set him to thinking and to talking As a consequence, he preached early operation to his students and to all of the medical societies in season and out of season, so that he had educated the entire community to the early detection of intussusception in infants He had eighty-one cases with only three deaths as a result, which illustrates that it is purely a question of early diagnosis and immediate operation Intussusception comprised one-fifth of all the cases exclusive of hernia It made up 40 per cent of the total number

He thought, contrary to Doctor Boland, that in post-operative intestinal obstruction the surgeon should be the first man to suspect it and the first to intervene, particularly with enterostomy If one goes back the third or fourth morning and the patient is vomiting when the anæsthetic is worn off, and there is pain with vomiting, and the patient is given two turpentine enemas and the symptoms are not relieved no matter if the lower bowels are moved, that patient has almost certainly intestinal obstruction and should have an enterostomy at once It is perfectly surprising how quickly the symptoms will subside and what a delightfully gratifying type of recovery one will have by prompt action in this group of cases The most dangerous thing that the surgeon meets with is the accidental or sometimes intentional evisceration of the patient If one can, with the clairvoyant hand find the "bunch" where the obstruction is and pack it off, particularly if it is a whipcord type of band that can be seized with forceps and clipped between, then one is home-free unless by chance it has been so long that one is fearful of leaving the distended coil without an enterostomy

He cited a case of obstruction in a woman who was six months pregnant and who had previously been operated on by him His associate did an enterostomy for intestinal obstruction She was relieved In two weeks she had another obstruction so severe that in the presence of the six-month pregnant uterus it was necessary to resect six inches of semi-gangrenous intestine, and do a second enterostomy The patient recovered but with two enterostomies

The second opening was high in the jejunum and the patient was slowly starving They devised a very simple obturation of the enterostomy wound A plain bolus of non-absorbent cotton (with oil in it) placed over the enterostomy wound, was strapped tightly with adhesive plaster It had the remarkable result of occluding the opening completely and directing the current downward and allowing it to gradually heal without leakage in a short time Although there was an area as large as a saucer around the high enterostomy of eroded skin, both of these fistulæ were cured quickly by the obturator effect of this ball of oiled cotton strapped over both enterostomy wounds with adhesive plaster

DR FRANK K BOLAND (Atlanta, Ga) said he did not think he had ever known of a case where a second surgeon was called in to operate for post-operative obstruction and

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probably never will know of one. He suggested that he might operate a little earlier than the man doing the first operation. Of the two cases of duodenal hernia reported as causing obstruction these cases have been previously reported as duodenal hernia by Doctors Cope and Phillips, in December, 1931. But wished to report them now as acute intestinal obstruction. It was only as acute intestinal obstruction that they were recognized. Munyon, in 1906, described the fossa through which these duodenal hernia might take place. One of these on the left side, known as the paraduodenal fossa, or fossa of Landzert, existed in the first case. The second most common place for these hernia to protrude is through the mesentery or parietal fossa. The first case was thirty years of age. Had been sick twelve hours with a certain onset of intense pain and nausea and vomiting. There was the development of abdominal swelling. At operation, the entire intestine was found to have gone through the left paraduodenal fossa behind the peritoneum. He had no bladder symptoms because the tumor mass was telescoping the bladder. In this case we reduced the hernia by pulling out the intestines and twisting the mesentery on its axis and the patient made a recovery. The second case died. Four feet of the intestine was gangrenous and it was resected, enterostomy done.

## ACUTE INTUSSUSCEPTION

By EDWIN M. MILLER, M.D.

OF CHICAGO, ILL.

IN THE present paper I shall endeavor to accomplish three things. First briefly to sketch the pathological and clinical picture in acute intussusception, second, to summarize the results in twenty cases that I have operated upon, and lastly, to point out the advantages of combined conservative and operative treatment.

Since the pioneer work of Nothnagel<sup>1</sup> and Leichtenstern<sup>2</sup> many years ago, when they attempted to produce intussusception in animals by the local application of an electric current or some powerful drug, such as physostigmine there has accumulated abundant evidence, both experimental and clinical, to show that under normal conditions an intussusception artificially produced tends readily to reduce itself, and that if it is to persist, there must be present either some gross pathological lesion within the bowel wall or within its lumen, or there must prevail some general pathological condition which locally upsets normal peristalsis, and allows one segment of bowel to telescope into another.

It is true that these pathological conditions may exist very high in the gastro-intestinal tract, as in the unusual case of Henke,<sup>3</sup> where the stomach wall was dragged through the entire duodenum by a pedunculated tumor or as a late complication of gastroenterostomy where several inches or even a few feet of the jejunum may suddenly be sucked upward through a stoma too generous in size (White and Jankelson<sup>4</sup>). It is true, also, that most times when a gross lesion can be demonstrated it is found along the terminal portion of the ileum, and usually proves to be either a pedunculated tumor, a lipoma, an inverted Meckel's diverticulum, or an area of local hæmorrhagic infiltration. But it is a universally recognized fact that the great majority of all acute intussusceptions begin at or near the ileo-cecal valve, and that easily 50 per cent of them occur in infants between the fifth and ninth month of life. This is not difficult to understand when one considers that it is during these early months, and especially during the weaning period, that abrupt changes in diet are apt to be made, that cathartics are too frequently given, that foreign bodies such as pins, buttons *etc.*, are liable to be swallowed by the creeping child, that anatomically there takes place a rather sudden disproportion between the calibre of the ileum and the large bowel (Power<sup>5</sup>), that the lymphoid tissue, so abundant in this region may easily become swollen (Perrin and Lindsay<sup>6</sup>), and that the ileum cæcum, and ascending colon have at this time a relatively long mesentery (Power<sup>7</sup>), permitting a wide range of motion.

In view, therefore of the possibility that an acute intussusception may

develop at any level in the alimentary tract, may be single or multiple, descending or retrograde in type, and have as its basis a wide range of pathological conditions, it is obvious that the clinical manifestations might vary a good deal, and yet, in the typical case, with its characteristic sudden onset, as out of a clear sky, in an infant previously healthy, the noticeable pallor, the vomiting, the subnormal temperature, the spasmodic attacks of abdominal pain, the passage of blood or blood-tinged mucus, and, finally, the presence of a palpable abdominal tumor, there is a clinical picture so classic that it should rarely fail to be recognized by the doctor who first sees the patient, and to an audience such as this it is so familiar that it scarcely need be mentioned.

The diagnosis having been made, what should be the method of treatment? True it is that spontaneous reduction sometimes takes place, perhaps more often than we suspect, or, if nothing at all is done, spontaneous sloughing of the invaginated bowel might occur, but surely neither of these remote possibilities can hardly be hoped for, much less be expected. Having in mind the rapidly changing pathology, with the imminent danger of complete obstruction, strangulation, and gangrene, one is simply confronted by an emergency, calling for rapid action, and the best combined judgment of the pediatrician and the surgeon. Without question, that procedure is best which, with the least amount of trauma, and the least degree of shock, brings about complete reduction of the invaginated bowel, removes the local exciting cause, if there be one, and minimizes the likelihood of recurrence. I have no doubt that during the early hours, especially in young infants in whom a local tumor is rarely present, and in whom the intussusception is almost invariably an ileo-cecal one, this may be satisfactorily accomplished by conservative means, perhaps sometimes by an enema given by the mother before the doctor is called, perhaps by gentle massage with the hand on the child's abdomen, or by gently distending the colon with warm water or barium under the fluoroscope (Stephens<sup>8</sup>), but the lack of knowledge as to the extent of the pathology, and the uncertainty of the completeness of reduction of the last few inches of damaged bowel, have always seemed to me a great danger, far outweighing whatever advantage either of these conservative methods might possess. I have, therefore, in a series of twenty cases of acute intussusception personally observed at the Children's Memorial, Presbyterian, and Cook County Hospitals of Chicago, always taken the position that no matter how young or how old the patient, how short or how long the duration of symptoms, or how favorable or unfavorable the prognosis, immediate operation was always indicated.

What have been the results? Eleven of these patients have lived, and nine have died, a mortality of 45 per cent. Of the eleven who survived, all but three were under one year of age, the duration of symptoms in only two was over twenty-four hours, reduction was accomplished in all but one case, and in three a lateral anastomosis was performed in order to short-circuit the irreducible tumor or an area of potential obstruction. Of the nine who

died, six were under one year of age, in five the duration was over forty-eight hours, in three, where the invagination could not be reduced, or a potential obstruction existed because of a greatly thickened bowel, death was not avoided by a short circuiting anastomosis, two required resection, one was in too poor condition to allow anything but an ileostomy, and finally, but most significant, two infants, both under one year of age, died even though reduction had been very easy, and the outlook had seemed very favorable

These results, though they compare pretty well with a series observed by other men of the Presbyterian staff in which the mortality was exactly 50 per cent, and with most larger series, such as that of Braum and Wortmann<sup>9</sup> (Fig 1) in 1924, in which five German clinics together reported an operative

171 CASES OF ACUTE INTUSSUSCEPTION TREATED BY PRIMARY OPERATION Reported by Braun and Wortmann 1923									
Clinic	Infants			Children			Adults		
	No of Cases	Recovery	Death	No of Cases	Recovery	Death	No. of Cases	Recovery	Death
Frommel (H Braun)	10	4	6	6	3	3	16	13	3
Michaelson (Ringel)	23	5	18	11	8	3	7	4	3
Goldschmidt (V Eiselsberg)	7	1	6	3	2	1	7	4	3
Wortmann (V. Braun & A. Neumann)	17	7	10	16	12	4	10	4	6
Flesch-Thebesius (Rehn)	17	2	15	16	11	5	5	3	2
Total	74	19	55	52	36	16	45	28	17
Mortality Rate	74 3%			31%			36%		

FIG 1

mortality of 74.5 per cent in infants, 31 per cent in children, and 36 per cent in adults, or that of Perrin and Lindsay<sup>10</sup> (Fig 2) from London in 1922, in which 400 consecutive acute intussusceptions all immediately operated upon, showed a mortality of 34.8 per cent, yet they appear very unsatisfactory when compared with results from those foreign countries where conservative methods have received a great deal of attention. I refer to Denmark, for instance, where from the old Clinic of Hirschsprung in Copenhagen, a report was made by Kock and Oerum,<sup>11</sup> in 1913, in which 380 cases of acute intussusception showed an operative mortality in infants under one year twice as great as that when conservative methods were used. But, in particular, would I call your attention to Australia, where, chiefly through the influence of one man, Charles Clubbe, the importance of early diagnosis and conservative treatment for many years has literally permeated the medical schools,

## ACUTE INTUSSUSCEPTION

the hospitals at Sydney, and has spread far and wide among the lay population. For instance, at the Royal Alexandra Hospital for Children at Sydney, over a period of twenty-five years 834 cases of acute intussusception were observed with an average mortality of 14.5 per cent, and one of Clubbe's assistants, Hipsley,<sup>12</sup> was able to report in 1926 a consecutive series of 100 cases with the almost unbelievable death rate of only 5 per cent.

Let us, for a moment, examine this report. We will observe in particular four things:

*First*, that no case is here recorded in which the diagnosis was not confirmed by palpation of an abdominal tumor.

RESULTS IN A SERIES OF 400 CONSECUTIVE CASES OF ACUTE INTUSSUSCEPTION Covering a period of 18 years from 1903-1920 Reported by Perrin and Lindsay in 1922 London Hospital England			
Year	No. of Cases	Deaths	Mortality
1903-05	74	42	56.7%
1906-08	64	26	40.6%
1909-11	68	23	33.8%
1912-14	81	18	20.9%
1915-17	67	12	17.9%
1918-20	46	18	39.1%
Total	400	139	34.8%
In this series immediate operative treatment was used without exception.			

FIG. 2

*Second*, that *sixty-two* of these 100 cases were successfully reduced by conservative methods alone, and in only *thirty-eight*, as a result of failure of conservative methods, operation had to be performed.

*Third*, of the *sixty-two* successfully reduced by conservative means, forty-four had no operation and there were no deaths, and in the *eighteen* (Fig. 3) in whom complete reduction was simply verified through a small incision, there was one death.

*Fourth*, of the *thirty-eight* cases in which failure of conservative methods made operation imperative, there were only four deaths.

Time does not permit a more detailed review of this remarkable report, else we might gather from it several instructive things, giving us a clue, per-



haps, to the secret of this unusual success, which seems to have no parallel in any other land Yet, we may safely assume that the following factors play a most important rôle

(1) The teaching of Charles Clubbe has without question exerted an

18 CASES OF ACUTE INTUSSUSCEPTION Successfully Reduced by Hydrostatic Pressure Alone But Verified by Operation P L Hipsley					
No	Date	Age	Duration	Result	Remarks
1	1918	9 months	12 hours	Recovery	
2	"	7 "	9 "	"	
3	"	11 "	17 "	"	Mass felt per rectum.
4	1919	9 months	10 hours	Recovery	
5	1920	5 months	22 hours	Recovery	Began 20 cm above ileo-caecal valve
6	"	6 "	5 "	"	Oper 6 hrs. after injec.
7	"	8 "	3½ days	"	because persistent vomit. Bowel greatly thickened at site of intuss
8	1921	7 months	18 hours	Recovery	
9	"	5 "	17 "	"	
10	"	9 "	10 "	"	
11	1923	5 months	21 hours	Recovery	
12	"	5 "	33 "	"	Thickened bowel after injection warranted oper.
13	"	10 "	3 days	<u>Death</u>	Pinhole perforation 2.5 cm above valve
14	"	9 "	24 hours	Recovery	
15	1924	5 years	5 hours	Recovery	Remarkable because of age Mass easily felt.
16	"	9 months	4 "	"	Diag appendicitis
17	"	4 "	24 "	"	3rd recurrence hence operation
18	"	12 "	3 "	"	Palpable tumor but no blood
					Oper because abd had not become distended after injection

FIG 3

enormous influence on the medical student body in Australia in the past twenty-five or thirty years

(2) The average doctor in general practice there must of necessity be very alert and capable of recognizing an intussusception in its early stage

(Witness seventy-three of 100 cases in Hipsley's series observed within twenty-four hours )

(3) Operative skill has doubtless been very highly developed, so that time has not been wasted, and unnecessary trauma has been avoided

(4) And most important, there has been perfected over a period of years a conservative method of treatment, which in their hands apparently may be employed with a minimum of uncertainty as to the completeness of reduction. What is the secret of this method? As described by Hipsley it is carried out as follows. Having facilities for operative interference at hand, the child is completely relaxed under anæsthesia, and the abdominal tumor gently palpated, being careful not to confuse it with the lobe of the liver. With the pelvis raised and the buttocks held firmly together, the warm water injection is begun. The flow is rapid, at first, proceeds then slowly and with resistance as the invaginated bowel is being pushed back, and continues more rapidly again as the loops above the intussusception become distended with fluid. This distention, which is generalized and symmetrical, is a most important sign, and together with the passage of gas and yellow fecal material in the return flow, and the disappearance of the tumor which had before been easily felt, gives one a feeling of certainty that reduction has been complete.

Regardless of what your experience or mine has been with intussusception, it is impossible in the light of evidence such as this, particularly from the Australian clinic, to ignore as being unscientific this time-honored and simple method of treatment. To be sure, it cannot always be solely depended upon, nor should it, and to advocate its use generally in this country might be unwise, since it would doubtless often be misused and misinterpreted, yet, if we ever hope to improve the alarming mortality in this, the most common cause of acute intestinal obstruction in early life, we must give this method the attention it deserves. For in young infants, under one year of age, who do not stand operation well, it may be all that is required, and in the older children and adults, in whom a tumor is so often present, if it be used only as a pre-operative measure it may so simplify the procedure that the operation may be completed in a very short time, and a great deal of shock and trauma be avoided.

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DISCUSSION—DR WILLIAM E LADD (Boston, Mass) said that they had recently been over the cases of intussusception that had occurred in the Children's Hospital of Boston in the last twenty-five years

Beginning in 1908 there were thirty-two cases in the first five-year period with a high mortality of 59 per cent That was gradually reduced until in the last period, 1928 to 1932, with ninety cases, the mortality was 14 per cent

In the last five-year period the mortality is lower regardless of the duration of symptoms But if the cases are grouped according to twelve-hour periods it will be seen that in sixty cases operated on within thirty-six hours after onset of symptoms there was no mortality, a fact that brings out very clearly the importance of early diagnosis and early operation The ability to get early diagnosis is dependent on one's ability of educating the general medical practitioner and the pediatrician to send the cases in during the early hours of the disease The diagnosis is not difficult and if the patients are seen early and thoroughly examined very few mistakes in diagnosis should be made

As to operative procedures there are one or two points which are important as factors in reducing the mortality First is the persistence of attempts at reduction Many times the first part of the reduction of an intussusception goes along very easily and the latter part, where the last few inches have to be reduced, becomes very difficult Annular pressure on the intussusciptens and stretching of the receiving ring will often make possible a reduction that at first seemed quite impossible It is very important to persist in that rather than to proceed with a resection at once The mortality of resection is extremely high

The next factor of importance is the liberal use of fluids by enema, both pre- and post-operatively One should appreciate the fact that the margin of safety, especially on the young infants, which most of these cases are, is pretty narrow No unnecessary operative procedure should be indulged in, such as removing the appendix or doing any of the procedures which have been recommended to avoid recurrence In this series of 372 cases there were seven recurrences and no mortality in the recurrences

He had not been able to effect a reduction by enema and be sure that it was completed

Not more than two weeks ago he had a child in which a barium enema was given The X-ray man insisted that the reduction was completed He did not feel certain about it When the patient was operated on, they still found about five inches of invaginated bowel

From resections, they had had very poor results They had had only two recoveries, one with lateral anastomosis and one with a double-barrelled enterostomy

DR ALEXIS V MOSHCOWITZ (New York City) referred to Chubb's report that many cases of intussusception were curable by the injection of fluids or insufflation of air into the rectum, saying that when he considered the difficulty, and not so rarely, even the impossibility, of reducing the last few inches of the intussusceptum manually, he had reason to doubt the great frequency of cures by anything less than operative measures As a result of his experiences, he had arrived at the conclusion that the only way to positively diagnose an intussusception is by the sense of sight

# MECKEL'S DIVERTICULUM IN ACUTE ABDOMINAL EMERGENCIES

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IN A symposium covering the manifold lesions classed under the heading of "The Acute Abdomen," it seems fitting to devote a short while to the scrutiny of those uncommon, but most interesting and bizarre morbid states caused by Meckel's diverticulum. Of recent years numerous enlightening articles on this subject have been written, and one becomes more and more ready to think of this anomaly in the diagnosis of puzzling abdominal lesions for which no more common etiological factor can be found. At the meeting of this Association last year Mason and Graham<sup>1</sup> presented an excellent review mostly devoted to one aspect of the subject, the presence of aberrant gastric mucosa in the diverticulum, with ulceration and hæmorrhage. Ulceration and hæmorrhage constitute an important phase of the pathological occurrences, though by far more common in children than adults. It is our purpose to classify briefly the more important recent literary contributions and add twenty-two cases, one of which has, however, been previously reported. The mode of formation of the Meckel's diverticulum, as an anomalous persistence of the yolkstalk of the embryo, is too well known, and has been too much discussed, to require recapitulation here. (Fig 1)

The pathological occurrences which may be encountered are classed by Aschner and Karelitz<sup>2</sup> as follows

(1) Completely pervious fistula (2) Sinus at umbilicus (3) Cyst of umbilicus (4) Enterocystoma (5) Fibrous cord from ileum to umbilicus (6) Meckel's diverticulum

The same group of conditions, as viewed rather from the clinical standpoint, and seen in children, are listed by Hudson<sup>3</sup> below

(A) 1, Gastric mucosa without perforation but with hæmorrhage 2, Gastric mucosa with perforation with or without hæmorrhage (B) Intussusception (C) Diverticulitis (D) Obstruction (E) Umbilical fistula (F) Neoplasm (G) Enterocystoma (H) Duplex ileum (I) Mesenteric cyst (J) Tuberculosis

The diverticulum may, while symptomatically silent, so to speak, give rise to profuse hæmorrhage, a condition seen most frequently in children, and liable to be confused with intussusception without diverticulum. The hæmorrhage often arises in patients who are apparently perfectly well, and presenting no acute abdominal signs or symptoms. The hæmorrhage usually comes from a peptic ulcer which is in the ileal mucous membrane adjacent to the aberrant gastric mucosa, or not far from it, at the neck of the diverticulum. The ulcer is not in the gastric mucosa itself. On the other hand, in adults, acute lesions are the rule rather than the exception, in our own twenty-two cases in older individuals, only one presented hæmorrhage, and in fact all of them had acute abdominal pain with accompanying signs

To dispose first of the picture as it appears in children, the extraordinary and interesting tabulation of Hudson<sup>3</sup> is given as an example Males, 66.6 per cent, Females, 33.4 per cent, Mortality, 22.2 per cent

Gastric mucosa with ulcer and hæmorrhage without perforation, ten, with perforation, four, intussusception, nine, diverticulitis, six, other obstruction, seven, umbilical fistula, one, duplex ileum, one, incidental, seven, total, forty-five

It is seen that in children the occurrence of gastric mucosa, with resulting hæmorrhage, fourteen in all, leads all the others in frequency of incidence, though exceeded by the combination of intussusception and "other obstructions," which together number sixteen. Acute inflammation is a low third, with only six cases



FIG. 1.—Complete Meckel's diverticulum without fistula. This diverticulum, which caused no symptoms, was found at autopsy (From Pathological Laboratory of Massachusetts General Hospital)

In adults, on the other hand, other acute abdominal lesions far outnumber the instances of hæmorrhage, and first on the list must be placed intestinal obstruction. Ochsner's<sup>4</sup> classification may here be quoted to advantage: (1) Intestinal obstruction (2) Diverticulitis (3) Ulceration (4) Intussusception

The mechanics of intestinal obstruction are worked out by Ochsner as follows: (A) With free unattached diverticulum: (1) Knot tied around gut (2) Dragging and kinking of loop of intestine by distended or cystic diverticulum (3) Twisting of bowel at origin of diverticulum (4) Chronic inflammation of diverticulum and intestine, with narrowing of lumen (5) Acute diverticulitis

(B) Diverticulum attached to abdominal wall or abdominal viscus: (1) Band con-

## MECKEL'S DIVERTICULUM EMERGENCIES

stricting or interfering with blood supply (2) Volvulus of loop of intestine passing under diverticulum and becoming twisted (3) Volvulus of intestine attached to diverticulum with point of attachment as fixed point of rotation (4) Strangulation over a tightly drawn diverticulum (5) Acute diverticulitis (6) Prolapse of intestine through umbilical fistula

The different possibilities are thus seen to be numerous, and any one of the above mechanical accidents may occur in conjunction with an acute diverticulitis which, in turn, may lead to perforation of the diverticulum itself

Mason and Graham<sup>1</sup> collected, including their own, thirty-three cases of bleeding from ulcer of Meckel's diverticulum, with a mortality of 33·3 per cent Of this group of cases fourteen also perforated, with a mortality of 42·8 per cent, whereas thirteen which did not perforate, and all of which were operated on, had no mortality whatever There was one case of acute diverticulitis

Jackson<sup>5</sup> reported nine cases in which hæmorrhage from the diverticulum was the leading feature, these were all infants or children, and all recovered Aschner and Karelitz<sup>2</sup> collected thirty-three cases, to which Cobb<sup>6</sup> added four more, including one of his own—a total of thirty-seven—presenting hæmorrhage in thirty, or 81 per cent, perforation or penetration in twenty-one, or 56 per cent

In contrast to these features, Harbin's<sup>7</sup> first thirteen cases were as follows Casual (no symptoms), five, acute and subacute inflammation, five, acute obstruction, one, volvulus, one, gangrene, one

In a second report Harbin<sup>8</sup> collected nineteen cases, five of which required more than one operation, in three of them the diverticulum was overlooked the first time, and, in two, post-operative obstruction occurred

Lower<sup>9</sup> collected fifty-two cases of intussusception caused by the diverticulum, adding two of his own, making a total of fifty-four, in these, recurrent attacks of obstruction were the rule, and hæmorrhage not so common Wolfson and Kaufman<sup>10</sup> have added four cases of acute diverticulitis, three of which perforated

The leading groups of cases, from the recent literature, and mentioned above, may be abstracted as follows

TABLE I  
*201 Cases of Meckel's Diverticulum*

Ulcers, with hæmorrhage or perforation, or both	93
Intussusception	63
Other intestinal obstruction	26
Acute inflammation	10
Miscellaneous	9
	<hr/> 201

Our own cases are tabulated as follows

AUTHORS' CASES	Total, forty (one previously reported, R H Sweet <sup>11</sup> ), causing acute symptoms, twenty-two, incidental, eighteen
Ages, eleven to twenty, seven, over twenty, fifteen	

The pathological findings were as follows (1) Obstruction, (A) bands or adhesions, nine, same with acute inflammation, two, (B) volvulus, three, same with acute inflammation, two, (C) adjacent mesenteric defect, with acute inflammation, one, with abscess, one, (D) intussusception, one, (2) acute diverticulitis (simple), three

The pre-operative diagnoses follow The two cases classed as "femoral hernia" were instances in which an inflamed diverticulum was found in the sac of a femoral hernia (the so-called Littre's hernia)

*Pre-operative Diagnosis*—Intestinal obstruction (not specified), fifteen, acute appendicitis, five, femoral hernia, two, perforated ulcer, one Only one had blood by rectum

The mortality was as follows recovered, sixteen, died, peritonitis, five, shock (?), one, mortality, 37.5 per cent

The pathological reports, given below, reveal only one case, in the seventeen in which a record is made, of the finding of gastric mucosa. Some of these date back a good many years, and it is possible that proper search was not made for the anomaly.

*Pathological Report*—Gastric mucosa, one, ileal mucosa, sixteen, not recorded, five, acute infections, seven, circulatory gangrene, ten, no report, five

**CASE REPORTS**—**CASE I**—Male, aged seventeen. Three acute abdominal attacks of which the last one was diagnosed acute obstruction. Some blood passed by rectum on giving enema. Operation revealed intussusception which was reduced with difficulty. Perforation found, and eighteen inches of intestine resected. Slow but eventual recovery.

**CASE II**—Male, aged fifty-seven. One attack diagnosed acute obstruction. Operation revealed the obstruction caused by a kink around a diverticulum which was five centimetres long. Three inches of intestine resected and ileostomy done. Patient died following secondary closure.

**CASE III**—Female, aged twenty-three. One attack diagnosed acute appendicitis. Operation revealed a diverticulum, acutely inflamed, with its tip adherent to the mesentery of the ileum and causing constriction of one loop of ileum. The diverticulum was excised, and the patient's convalescence was uneventful.

**CASE IV**—Male, aged twenty-four. One attack, diagnosed acute obstruction. Operation revealed obstruction caused by a thick band extending from the tip of an inflamed diverticulum and adherent to the root of the mesentery, strangulating beneath it a loop of intestine. The band was severed and the diverticulum removed. The convalescence was uneventful.

**CASE V**—Male, aged twenty-six. One attack, diagnosed acute appendicitis. There was an abdominal opening in the mesentery of the small intestine through which opening a loop of terminal ileum had herniated, and this loop was held *in situ* by a gangrenous ruptured diverticulum which was adherent in the left upper quadrant of the abdomen. An abscess had formed. The diverticulum was freed and removed, and the hernia reduced. The patient died of peritonitis.

**CASE VI**—Male, aged forty-five. Patient complained of a lump in the right groin which had followed exertion one month previously. This mass was not tender, but was irreducible. The pre-operative diagnosis was incarcerated femoral hernia. At operation the sac was found to contain adherent bowel, which was an incarcerated diverticulum. Removal was followed by uneventful recovery.

**CASE VII**—Male, aged seventy-two. (This case reported by Sweet<sup>21</sup>) The patient complained of a recently developed mass in the right groin, the mass was painful but caused no vomiting or generalized abdominal pain. Examination showed a hard, tender irreducible mass, diagnosed incarcerated femoral hernia. Operation revealed an inflamed adherent diverticulum, twelve centimetres long, in the hernial sac. The diverticulum was removed and hernia repaired. Convalescence was uneventful.

**CASE VIII**—Male, aged eleven. One attack of acute abdominal pain diagnosed as acute appendicitis. Operation revealed a hernia of six inches of ileum through a defect in the mesentery of the small intestine, and the herniated bowel was prevented from reducing itself by an acutely inflamed Meckel's diverticulum which was adherent to the posterior abdominal wall. The hernia was reduced, the diverticulum and the appendix were removed. Uneventful recovery took place.

**CASE IX**—Male, aged fourteen. There was a history of several attacks of acute abdominal pain. On admission to the hospital there were pain, vomiting, slight distension, active peristalsis, slight tenderness and no spasm, the diagnosis was acute intestinal obstruction. Operation revealed a volvulus of a loop of ileum around an acutely inflamed diverticulum which was adherent over the caecum. The volvulus was relieved, and the diverticulum and the appendix were removed. Convalescence was uneventful.

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CASE X—Male, aged twenty-eight Attack of extremely severe abdominal pain of two and one-half hours' duration No previous gastro-intestinal disorder The abdomen presented extreme tenderness and spasm Diagnosis—perforated peptic ulcer Operation revealed a volvulus of a loop of ileum at a point where a Meckel's diverticulum was adherent to the mesentery of the terminal ileum The loop was freed and the diverticulum was removed Recovery was uneventful

CASE XI—Male, aged fifteen The appendix had been previously removed The history was one of six days of increasing abdominal cramps, with vomiting and obstipation Diagnosis was acute intestinal obstruction Operation revealed a volvulus of a loop of ileum twisted one and one-half times, due to an inflamed Meckel's diverticulum adherent to the old scar The volvulus was freed and the diverticulum removed Convalescence was uneventful

CASE XII—Male, aged thirty-two History of abdominal pain at intervals for six years The present attack had continued about twenty-four hours, and was thought to be due to a mild acute appendicitis Operation revealed an acutely inflamed diverticu-

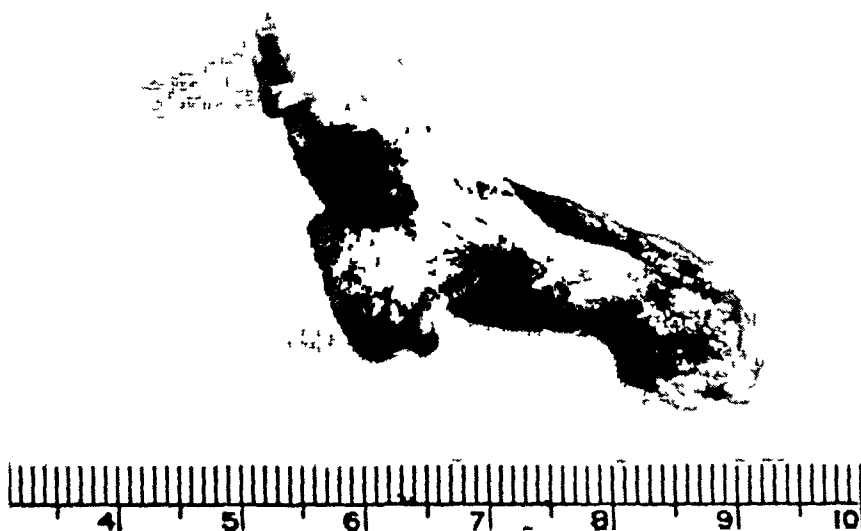


FIG 2—A Meckel's diverticulum, subacutely inflamed, probably causing symptoms, found at exploratory laparotomy Patient a male of thirty five

lum, five centimetres in length, arising from the side of the terminal ileum This was removed, and the patient's recovery was uninterrupted

CASE XIII—Male, aged twenty One attack of acute abdominal pain of three days' duration, with vomiting, and no bowel movements, even with enemas Had been given much morphine Examination showed the abdomen rigid and distended The diagnosis was intestinal obstruction Operation revealed a black coil of small intestine, twisted on itself, with a gangrenous Meckel's diverticulum at its summit The volvulus was untwisted, the diverticulum removed, and drainage established The patient died of general peritonitis

CASE XIV—Male, aged thirty History of two attacks of which the recent one had lasted two days The general picture warranted a diagnosis of intestinal obstruction, though it was not recorded Operation revealed a diverticulum adherent to the abdominal wall in the region of the internal inguinal ring, also a constricting band, causing obstruction The diverticulum and appendix were removed, and the band severed The patient died, cause of death not determined (Fig 2)

CASE XV—Female, aged forty-four One attack of acute abdominal pain, chiefly in the left lower quadrant, with symptoms and signs leading to a pre-operative diagnosis of intestinal obstruction Operation revealed an obstruction due to a diverticulum



adherent in the region of the left iliac vessels Removal of the diverticulum relieved the obstruction and the patient had an uneventful recovery

CASE XVI—Male, aged forty-three History of acute attack of four days' duration, typical of intestinal obstruction Precise diagnosis not made before operation, which failed to reveal the cause of the trouble Ileostomy was done but the patient died of peritonitis Autopsy showed the obstruction due to an adherent Meckel's diverticulum

CASE XVII—Male, aged twenty-three History of acute attack of four days' duration, ending in complete obstruction and fecal vomiting The diagnosis was intestinal obstruction, and operation showed it to be due to a Meckel's diverticulum adherent by a strong band to the anterior abdominal wall The diverticulum was removed and the band freed, resulting in complete recovery

CASE XVIII—Male, aged twenty-six Acute attack of abdominal pain of four days' duration Temperature 103° Pulse 160 Abdomen distended, tender, and tympanic Diagnosis not recorded Operation revealed a twisted gangrenous Meckel's diverticulum springing from the lower ileum and adherent to the under surface of the umbilicus In the course of removing this it ruptured The patient died of general peritonitis

CASE XIX—Male, aged eleven Acute abdominal attack of one day's duration Diagnosis not recorded Operation showed the small intestine to be obstructed by an adherent Meckel's diverticulum Following removal, convalescence was uneventful

CASE XX—Male, aged thirty There was a history of recurrent attacks of acute abdominal pain for a period of several years No positive diagnosis was made Exploratory operation revealed an acutely inflamed Meckel's diverticulum and what appeared grossly like an equally inflamed appendix The pathological report was "acute diverticulitis and acute peri-appendicitis" The patient's convalescence was very protracted and stormy, due to a hæmorrhage from the meso-appendix

CASE XXI—Male, aged twenty-six The appendix had been removed six years before, and this operation was said to have been followed by peritonitis and a pelvic abscess The present attack was of acute pain, and vomiting of fecal material The pre-operative diagnosis was acute intestinal obstruction Operation revealed a black and gangrenous Meckel's diverticulum running from the ileum down to the right side of the pelvis, and under this a loop of small intestine was caught and obstructed The diverticulum was removed, but ruptured in doing so, and drainage was established The patient recovered after a rather stormy convalescence

CASE XXII—Female, aged forty Ten days after a vaginal hysterectomy she developed signs suggestive of intestinal obstruction, but she was carefully watched for two days before operation seemed imperative The diagnosis was acute obstruction Operation revealed a Meckel's diverticulum caught down and adherent to the recent wound at the upper end of the vagina The diverticulum was freed up and removed, and the patient's convalescence was uneventful

*Conclusions*—A review of the literature, and a further analysis of the above cases, must impress the surgeon with the necessity of always bearing in mind the possibility that Meckel's diverticulum, which occurs in about 2 per cent of all human beings, and which is so protean in its manifestations, may be the etiological factor in any acute abdominal emergency It should always be thought of in the cases which are difficult of diagnosis Search should always be made for it, when feasible, in an exploratory laparotomy and particularly at the time of removal of the so-called chronic appendix

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DISCUSSION—DR ALFRED BROWN (Omaha, Neb) reported a pathological condition of Meckel's diverticulum which illustrated a principle emphasized several times that morning It is, if the injured portion of the intestine is brought outside the peritoneal cavity and then kept outside the peritoneal cavity, a good deal of surgical manipulation can be done away with This allows the surgeon to follow the principle that the least amount of surgery done in these cases, the better for the welfare of the patient The patient was twelve years of age He entered the hospital with all the symptoms of what was considered an attack of acute appendicitis On making an incision, there was apparently not enough trouble found in the appendix to account for the symptoms Further search revealed a band leading to the umbilicus, and when this band was divided a completely gangrenous Meckel's diverticulum was brought out of the abdominal wound This was rotated on its long axis, there being about one and a half turns at its base An interesting point in this case is, that contrary to the teaching of most of the anatomical text-

books the statement made by Milese\* holds true that Meckel's diverticulum has a blood supply of its own which runs to the tip through a mesentery which passes in front of the ileum

In this case, there was a distinct line of demarcation between the normal gut of the small intestine and the gangrenous portion of the Meckel's diverticulum. The boy was in very bad condition. There was a certain amount of peritonitis. There was considerable serosanguineous fluid in the peritoneal cavity. He had a count of 29,000 white cells and 94 per cent of polymorphonuclear leukocytes. Instead of trying to do a resection a clamp was placed at the base of the Meckel's diverticulum, and a dressing was placed around it. The boy was put back to bed and the diverticulum allowed to slough off. This it did in five days. Although the convalescence was rather stormy, he made a good recovery. The fecal fistula left after the operative procedure closed gradually and he was discharged from the hospital in fifty-nine days.

DR WILLIAM B COLEY (New York City) remarked that in 1920 he reported a case of strangulated hernia from Meckel's diverticulum before the Southern Surgical Association, together with a review of seventeen additional cases collected from the literature. The rarity of the condition is shown by the fact that Balfour, in a review of 10,000 successive operations performed at The Mayo Clinic from 1907 to 1910, found only fifteen cases of Meckel's diverticulum, only five had given rise to symptoms, and only one of these was operated upon for acute intestinal obstruction due to adhesions about an inflamed diverticulum. There was no case of strangulation. His own case was a man, aged twenty-six years, who was admitted to the Mary McClellan Hospital, Cambridge, New York, June 6, 1920, at 7 P.M. He was a farmer who had always enjoyed excellent health. On the day of his admission he had eaten a good breakfast. Shortly afterwards he felt slight nausea and discomfort in the epigastrium. One hour later he began to have severe paroxysmal pains low down in the abdomen, which he characterized as "doubling-up" pains. These recurred at intervals of a few minutes. He vomited for the first time one and a half hours after his breakfast, and twice in addition before the operation.

On admission he showed slight tenderness in the right iliac fossa and region of McBurney's point, but no rigidity. Rectal examination negative, no mass palpable in any portion of the abdomen, no localized distension. Temperature, 98.6°, pulse, 72. Blood test: whites, 12,400, polymorphonuclears, 90 per cent. While he was unable to make a diagnosis he did not regard the condition as one of acute appendicitis. He felt that the steadily increasing paroxysmal pains rendered an exploration imperative. An immediate operation was performed. The appendix was found to be normal. A careful search revealed a loop of small intestine, about one and one-half to two feet in length, greatly distended and dark in color but not gangrenous, located in the bottom of the abdomen, somewhat more to the right side than to the left, a little above the pelvis. The loop of bowel was firmly attached to the pelvis below and connected with the small intestine above. The constriction was so tight that it was absolutely impossible to withdraw or to free the strangulated loop. It soon became apparent that they were dealing with a Meckel's diverticulum, nearly of the same calibre as the normal small intestine, coming off at a right angle from the lower portion of the ileum, about two feet from the ileocecal valve and extending downward to the root of the mesentery. The diverticulum was removed and after a short time the dark-colored bowel regained its normal color. The patient made an uneventful recovery.

DR JAMES MORLEY HITZROT (New York City) related the case of a little girl of twelve who came to the hospital with an obscure intestinal bleeding. She had an onset of pain in the right side. Her temperature was 100°, leucocyte count 10,000 with nothing particularly noticeable about it. In examining her stool, ova of the ascaris were

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\* Milese, Choyce. System of Surgery, vol. II, p. 442

## MECKEL'S DIVERTICULUM EMERGENCIES

found. She was treated for ascarides which removed the worm and her bleeding stopped. Therefore, he thought the bleeding was due to the ascaris. She came back on two occasions. She had acute abdominal pain, usually following some indiscretion in her diet. She was sent by her physician with the diagnosis of appendicitis. He went over her carefully. Her tenderness was at the umbilicus and above it and suggested some form of gastroenteritis which with a little diarrhoea made that diagnosis seem likely. She finally came to the hospital as an acute appendicitis case. He found an acutely inflamed diverticulum about twenty-two inches from the valve.

The curious fact in her case, which they found on asking her afterwards, was that during the period she was under observation, which was about a year and a half after the ascaris experience, she had not mentioned bleeding as a major symptom, but on close questioning she stated she had had bleeding from the time she was about nine years old up to the time that she was operated upon. A point which Doctor Miller emphasized in these obscure forms of bleeding from the intestine in children as suggested by Meckel's diverticulum.

Doctor Hitzrot said he failed then to recognize that fact, although he learned it later. That is a rather important point in helping to a diagnosis.

DR FRED B LUND (Boston, Mass.) said, as to Meckel's diverticulum, that since a certain experience, he had made it a rule to look for it in all cases of appendicitis where the appendix does not seem to be much diseased. He was called into consultation on account of obstructions by adhesion. He found the patient with a slight temperature and enormous distention. The intestines were red and inflamed. He did not dare to do anything but an enterostomy. A week later, the distention having gone down, he explored to find what the cause of the obstruction was. It was a gangrenous Meckel's diverticulum lying in the bottom of the pelvis, which was the trouble all the time. He removed it, but it was too late, and the patient died.

He often finds a Meckel's diverticulum in operating for other troubles in the abdomen. He usually lets it alone. Before operating if there is any history of hæmorrhage, it would be wise to remove it as soon as it is found although he had never done it.

DR CHARLES G MIXTER (Boston, Mass.) recently had an opportunity to analyze a series of seventy-six instances of Meckel's diverticula. Forty-six of these were seen at the Children's Hospital of Boston, forty-five of which were reported by Hudson, eight from the Beth Israel Hospital as well as the twenty-two that Doctor Miller was good enough to let him review, perhaps prematurely. Of these, sixty-three had acute abdominal symptoms. If these sixty-three cases are divided into two general groups, in the one group putting the infants and children, in the other group the adults and the older-aged patients, one finds that the pathology is very definitely different in the two series of cases. In the Children's Hospital series, reported by Hudson, the preponderant symptom is hæmorrhage. Intussusception occurs frequently but the cases of hæmorrhage are the salient ones, and intestinal obstruction from other causes is rare. On the other hand, in the older-age group the cases of outstanding hæmorrhage from ulceration caused by gastric heterotopia in the sac are rare, whereas the cases of intestinal obstruction predominate.

If the fourteen cases represented with hæmorrhage be combined with those with Mason's thirty-three collected cases, they can be divided into two groups: first, those cases in which hæmorrhage alone has been the feature. It may have been extremely massive but the mortality in that group is 5 per cent. When intestinal obstruction is associated with the hæmorrhage, a sudden rise in mortality to 50 per cent is encountered.

## WANDERING SPLEEN WITH TORSION OF THE PEDICLE

BY IRVIN ABELL, M D

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UNDER certain conditions which permit loosening of its attachments the spleen descends from its normal position in the left hypochondrium into the abdomen. When the elongation of its pedicle is such as to allow its appearance in other than the left upper abdominal quadrant it is designated as a wandering or floating spleen. The factors concerned in its abnormal mobility are both congenital and acquired. The former are chiefly two, the length of the splenic pedicle and the conformation of the abdominal cavity. In the latter the area between the intercostochondral arches is materially diminished while the paravertebral niches are definitely shallower, as a result of which intra-abdominal pressure is diverted from its normal direction and prolapse occurs. The acquired factors may be grouped under two headings, increased weight of the spleen and the conditions which bring about relaxation of the abdominal wall and of the ligaments which support the abdominal viscera. While either of these factors may be the determining one in a given case, in a majority of instances two or more will be found to have contributed to the splenoptosis. When the mobility of the spleen attains an extent that will allow axial rotation on its pedicle, torsion of varying degree may result with more or less disastrous consequences. Two such instances have come under my observation.

CASE I—A white woman, aged thirty-four, robust and well developed, came under my care in 1912. She gave no history of previous illness or of symptoms related to the spleen. She had borne one child and at the time of the then present illness was three and one-half months pregnant. While engaged in household duties she was seized with sudden, abdominal colic attended with nausea and vomiting. She was admitted to the hospital forty-eight hours after the onset of the attack, at which time she had a temperature of  $101\frac{1}{2}^{\circ}$  and pulse of 110. The right half of the abdomen was rigid and tender and presented a tumor which extended from the pelvic brim to a point above and to the right of the umbilicus. Pelvic examination revealed a pregnant uterus with the tumor lying in contact with its right upper surface. The urine was negative. The blood count showed a leucocytosis of 12,000 with an increase in the polymorphonuclear cells. Operation revealed the tumor to be the spleen, approximately two and one-half times the normal size. It was not adherent and was easily delivered through the incision. The pedicle showed two complete turns, the tail of the pancreas being incorporated in its proximal end. This was disengaged by detorsion, the pedicle ligated and the spleen removed. The latter showed intense congestion but no thrombosis of the vessels. The patient made a good recovery and underwent normal delivery five and one-half months later.

CASE II—White woman, aged forty-six, thin and ptotic in physique, came under observation in 1919. She had borne four children and had passed the menopause seven years before. She gave a history of digestive disturbance extending over a period of years but had had no colic until the onset of her present illness. The latter was charac-

## TWISTED PEDICLE OF WANDERING SPLEEN

terized by severe cramps in the abdomen lasting three days, accompanied by nausea, vomiting and fever. Following the subsidence of the cramps the right lower quadrant became exquisitely sensitive and a mass became apparent. At the time of her admission to the hospital, two weeks after the onset of her illness, she presented a fixed mass in the right lower quadrant which was extremely sensitive. Pelvic examination showed an atrophic uterus, tubes and ovaries not palpable. Urine showed a trace of albumin, some granular casts, otherwise negative. Blood showed hæmoglobin of 80, red cells, 4,000,000, white cells, 10,000. Operation revealed a tumor completely covered by omental and intestinal adhesions except at its upper pole. Upon separation of adherent omentum and intestine the tumor proved to be the spleen. The pedicle showed two complete turns and presented thrombosis of both artery and vein. The surface of the spleen showed a number of spontaneous ruptures from which no bleeding had taken place, indicating that they had occurred subsequent to the occlusion of the arterial blood supply by torsion. Capillary oozing from raw surface on adhered organs controlled by ligatures and hot packs, pedicle ligated and spleen removed. Recovery was delayed by a right femoral thrombophlebitis, the patient being discharged from hospital four weeks after operation. This spleen weighed 370 grams, was of dark, reddish-gray color, smooth, with a few fine, fibrous tags attached over its diaphragmatic surface. The organ consisted of two almost completely separated lobes with a fissure between, extending from the hilus over the anterosuperior surface down to the inferior margin. On the diaphragmatic surface there was a transverse fracture near the lower pole, forty-seven centimetres long, two to three millimetres wide and about 5 millimetres deep. A crescentic fracture was found near the upper pole posteriorly, thirty millimetres long, six millimetres wide and seven millimetres deep. In the parietal surface was an L-shaped longitudinal fracture near the hilus, sixty-three millimetres long with an arm twelve millimetres long, four millimetres wide and six millimetres deep. In the diaphragmatic surface near the anterior border was a fracture thirty-three millimetres long, three millimetres wide and eight millimetres deep extending longitudinally from the end of a cleft. On section the pulp was very dark reddish-brown, almost black, except near the capsule, where it was reddish-gray. No Malpighian corpuscles were apparent. The vessels were thrombosed.

In a review of the literature we have been able to find ninety-five reports of wandering spleen with torsion of the pedicle, in addition to the two cases herewith recorded. No case has been included in which torsion of the pedicle is not specifically mentioned as a causative factor in the production of symptoms and pathology. The pertinent facts, as revealed by an analysis of these reports, are shown in the following tables.

AGE AND SEX

Age	Female	Male	Total
1-10	0	1 (age 6)	1
11-20	9	2	11
21-30	28	1	29
31-40	26	1	27
41-50	11		11
51-60	3		3
61-70	1		1
71-80	1		1
Not stated	9		9
Age and sex not stated			2
Totals	88	5	95

It is interesting to note that twelve, or 14.3 per cent, were observed before the age of twenty, while fifty-six, or 66.7 per cent, occurred between the ages of twenty and forty, leaving but 16, or 19 per cent for the years of normal physical decline. Of the ninety-three cases in which the sex was stated but five were noted in males. In the group occurring before the age of twenty it would seem that congenital factors played the predominant etiological part since the conditions which give rise to abdominal distension and atony were absent. In the group of twenty-nine occurring between the

PHYSICAL DEVELOPMENT

Normal	11
Obese, robust or muscular	9
Spare, thin or delicate	12
Asthenic or ptotic	13
Not stated	50
	—
Total	95

MALARIA

History of	Splenic Enlargement Before Torsion	Size of Spleen When Removed
I	I	2190 gms
I		
I, no history, parasites found		1350 gms
I		
I	13 years	4200 gms
I	1 ½ years	1200 gms
I		1520 gms
I		
I	3 years	37x22x12 cm
I		1750 gms
I	I	400 gms
I	I	5 to 6 times normal
I	I	2100 gms
I	I	3500 gms
I	I	800 gms
I	I	3000 gms
I	2 years	1000 gms
I	3 years	1600 gms
I	2 years	2125 gms
I	7 years	750 gms
I	I	1635 gms
I		25x18 cm
I		
I	3 years	1870 gms
I		
I	I	710 gms
I		1520 gms
I		1540 gms
I	17 years	840 gms
	—	
Total, 29	18	

## TWISTED PEDICLE OF WANDERING SPLEEN

ages of twenty-one and thirty, constituting 34.5 per cent, at a time of life when physical development is presumably at its highest, it is reasonable to presume that congenital causes could not be entirely excluded in the determination of etiology.

Of the forty-five cases in which physical development was registered but twenty-five were recorded as belonging to the types in which ectopia is commonly found, the remaining showing normal or robust physique. While the spleen may participate in a general visceroptosis it is frequently the one organ which remains in its normal position and again it is often the one organ showing ptosis when the remainder evince no such tendency.

A history of malaria was given by twenty-eight patients and the parasites found in a twenty-ninth who gave no such history. In eighteen there was a known presence of splenic enlargement or "ague cake" before the advent of torsion. Even in the presence of such an incidence it is evident that the weight of the spleen is not the prime factor in its displacement and torsion since in no history is there mention made of tumor or splenomegaly of other origin in which prolapse and torsion were complicating features. The splenic enlargement common to Banti's and Gaucher's disease, leukæmia and hemolytic jaundice is usually unassociated with prolapse even in the absence of anchoring adhesions. Of the twenty-one cases in which the weight of the

### PREGNANCY AND THE PUERPERIUM

#### 88 Females

Parous	Cases	Torsion During Pregnancy or the Puerperium				
P	3	1	Pregnant 4 mos	Splenectomy		Recovery
P	7	1	Pregnant 5 mos	Splenectomy		Died
1 P	8	1	Pregnant 2 mos	Splenectomy		Recovery
2 P	6	1	Pregnant 4 mos	Splenectomy		Recovery
3 P	5	1	Pregnant 5 mos	Splenectomy		Died
4 P	4	1	Pregnant 3 mos	Abortion during attack	Splenectomy	Recovery
5 P	6	1	Pregnant 5 mos	Abortion 24 hrs after op	Splenectomy	Died
6 P	4	1	Pregnant 4 mos	Splenectomy		Recovery
7 P	3	1	Pregnant 2 mos	Exploration and drainage		Died
8 P	1	1	Torsion several days after delivery	Splenectomy		Recovery
9 P	2	1	Pregnant 3 days after delivery	Splenectomy		Died
10 P	1	1	Pregnant 2 weeks after delivery	Splenectomy		Recovery
14 P	1	Total—12 Deaths—5 Recoveries—7				
<hr/>						
Total	51					
Non-P	21					
Not						
stated	16					
<hr/>						
Total	88					

The autopsy records of two, both in the fifth month of pregnancy are given

(1) Operative diagnosis, Torsion of pedicle with intestinal obstruction death sixth day. autopsy purulent decidua endometritis due to strangulation of intestine

(2) Operative diagnosis, Torsion of pedicle Death fifth day Autopsy purulent decidua endometritis, endocarditis, hypostatic pneumonia, pulmonary œdema



spleen was recorded at the time of removal, sixteen had noted splenic enlargement for periods varying from one to seventeen years, the weight of the organ in the twenty-one cases ranging from 400 to 4,200 grams, the average being 1,695 grams. Uncomplicated malarial splenomegaly does not as a rule attain such size, the enlargement in these instances being augmented by the changes incidental to the altered circulation.

Of seventy-two females in whose record the obstetrical history is given, twenty-one are classified as non-parous and fifty-one as parous, of the latter eight were uni-parous, three parous, seven multiparous, while thirty-three had borne from two to fourteen children each. The latter group doubtless forms the basis for the statement that prolapse of the spleen occurs most frequently in women whose abdomens have become inelastic from numerous pregnancies. It is readily granted that flaccidity and relaxation of the abdomen resulting from repeated pregnancies furnish the ideal conditions for such prolapse but a further explanation must be sought in the twenty-one non-parous women and in the five males forming 26.4 per cent of the total number under discussion. The gravity of splenic torsion in the course of pregnancy and the puerperium is graphically shown by the mortality rate of 41.7 per cent in the twelve cases reported. In two abortions occurred during the acute attack, one before and one after splenectomy, one dying and one recovering. In three torsions occurred after delivery, one dying and two recovering following splenectomy. Of the remaining seven operated on during pregnancy, six by splenectomy and one by exploration and drainage, three died and four recovered.

#### PREVIOUS HISTORY

One or more colics	19
Abdominal discomfort, digestive disturbance, one with malena	10
Tumor known to be present, no other symptom mentioned	25
Tumor known to be present, with colics or discomfort	3
Pelvic pain and discomfort, 1 with malena, 1 with uterine hæmorrhage	4
Previous history not stated	34
	—
	95

#### DURATION OF ATTACK AT TIME OF OPERATION

Acute, Under 2 Weeks, 58		Chronic, Over 2 Weeks, 37	
Acute	58	2 mos	3
Time stated	13	5 weeks	1
Chronic—Time not stated	24	4 mos	2
	—	4 weeks	1
	95	Several days	1
		8 weeks	1
		2 weeks	3
		1 mo	1
		Time not stated	24
			—
			37

History of acute onset following lifting heavy weight given in seven

## TWISTED PEDICLE OF WANDERING SPLEEN

In sixty-one cases there is a history of symptoms antedating the torsion which may be justly ascribed to the splenic displacement, in twenty-eight of which a tumor was known to be present. Colics of mild type, presumably due to partial twists of the pedicle, were noted in nineteen. Digestive disturbances due to pressure and to traction on the stomach, intestine and pancreas were commonly noted in these and were the only symptoms observed in ten. Pelvic discomfort, disturbance of menstruation, vesical and rectal tenesmus have been noted when the spleen occupied a pelvic location. Both metrorrhagia and menorrhagia have resulted from pressure and secondary circulatory change.

In thirty-four no symptoms are mentioned other than those noted with the initial attack. The attacks may be classified as acute, subacute and chronic. The symptoms of the acute attacks, barring the known presence of a wandering spleen, offer nothing conclusive other than the presence of a major abdominal disaster. Pain, nausea and vomiting with elevation of pulse, temperature and leucocyte count are usually present. Such an onset with variation in intensity of symptoms is described in fifty-eight cases. In the subacute and chronic varieties the torsion of the pedicle has stopped short of strangulation or the patients have survived the acute onset with the spleen more or less isolated by adherence of omentum and intestine with symptoms directed to the site of the misplaced organ. In instances in which the spleen was known to have been mobile and in others in which a movable tumor had been noted, comment is made upon the rapid enlargement of the tumor following torsion. In thirteen instances the duration of the attack as stated varied from several days to four months while in twenty-four the time is not stated. The description of the findings in the latter group indicates them to be of the chronic type.

LOCATION OF TUMOR	
Location given	85
Right upper quadrant	2
Left upper quadrant	7
Epigastrium	2
Mid-abdomen	4
Right half abdomen	3
Pelvis and abdomen	13
Abdomen	6
Right lower quadrant	9
Left lower quadrant	8
Hypogastrium	4
In all four quadrants	2
Left half abdomen	15
Pelvis	10
Location not mentioned	7
Tumor not detected, distension and rigidity	3
Total	95
Number palpable through vagina and rectum, 34	

The displaced spleen escaped detection in but three instances, the distension and rigidity effectually hiding it. In seven no mention is made of loca-

tion and in six the tumor is merely described as being in the abdomen In seventy-nine the tumor is accurately located and it interesting to note that in but seven was it found in the left upper quadrant The length of the pedicle offers the only limitation to its wandering proclivities, it being found in all parts of the abdomen and pelvis In the latter it may rest on the uterus forcing the latter into a retroverted position or it may lie in the cul de sac behind the uterus Mention is made in thirty-four of the histories of the tumor being palpable through the vagina or rectum

# PRE-OPERATIVE DIAGNOSIS

Prolapsed spleen or kidney	1
Kidney	1
Tumor left kidney or ovary	1
Hydronephrosis right kidney with twisted pedicle	1
Appendiceal abscess	1
Acute appendicitis	1
Appendicitis with peritonitis	1
Ovarian tumor	8
Ovarian tumor with twisted pedicle	11
Ovarian cyst, twisted pedicle with intestinal obstruction	1
Hydrosalpinx or tubo-ovarian cyst	1
Uterine or ovarian tumor	1
Uterine fibroid	1
Cyst	1
Hæmatocele	1
Tumor omentum or mesentery	1
Sacrococcygeal tumor	1
Intestinal obstruction	1
Peritonitis or obstruction	1
Peritonitis, indeterminate	1
Tumor	9
Spleen	2
Enlarged spleen	1
Inflamed spleen	1
Floating spleen	1
Floating spleen with twisted pedicle	1
Wandering spleen	1
Wandering spleen or hydrated cyst	1
Wandering spleen, fixed	2
Movable spleen or peritonitis	1
Dislocated spleen	1
Dislocated spleen with twisted pedicle	4
Diagnosis not stated	33
	—
Total	95

When one notes the varying locations in which the spleen has been found, in all but seven of which it was widely distant from its normal position, one is prepared for the failures in diagnosis In thirty-three the condition was recognized as an acute abdominal catastrophe but no pre-operative diagnosis charted In nine it was tumor of unknown origin In twenty-three the tumor was thought to have originated in the ovary or uterus In but nineteen

## TWISTED PEDICLE OF WANDERING SPLEEN

was the spleen recognized as the organ at fault while in the remainder obstruction, peritonitis, the omentum, appendix and kidney, hæmatocele and sacrococcygeal tumor were suspected. When a history of splenic enlargement or mobility was lacking and the tumor was located other than in the left upper quadrant, its origin was obviously thought to be connected with the organs normally situated at its point of lodgement.

### BLOOD COUNT

Made	48
Not made	47
	—
Total	95

Before and After Operation, 11		After Operation, 13	
15500	Normal in 1 mo	17000 — 15000 — 14000	
28000	Normal in 4 mos	7000	With decreased lymphocytes
28700	10000	2	Increased blood-platelets
13500	10650	10000	4 months later 50000
7000	Normal	14000 — 7000	
10000	Increased lymphocytes	30000	
Normal	Increased white cells	14400	
Increased whites	Normal	13760 — 12500	
12200	43000	Normal	
17800	14800	14000	
11300	27000 — 10000	5600	
		30000 — 10000	

Low Hem & R C	Normal W C	Increased W C	2
Inc, B P	1	Increased W C with parasites	1
Malarial parasites	1	Anæmia of pernicious type with	
Anæmia	Normal W C 3 yrs later	megalo- and normoblasts, poikilo-	
16000	1	cytosis	1
Low R C	Normal W C	Normal blood counts	12
Normal white count	1	8400 before operation, none after	1
Low R C	Increased W C		
	1		

Blood counts at some time in the course of the calamity were made in forty-eight of the ninety-five cases. With but few exceptions the blood study has not been carried out through complete convalescence. Normal counts are reported in a rather surprisingly large number of cases, the inference being that the degree of torsion was not sufficient to produce marked circulatory changes in the splenic tissue. With the acute torsions the number of leucocytes has uniformly been increased, the differential count showing nothing distinctive. Following splenectomy the red cells showed a temporary decrease with rather rapid replacement; the white cells, a gradual decrease with a temporary preponderance of lymphocytes. Increased blood-platelets were recorded in but two. The blood count, as a rule, has regained its normal proportions in from one to four months. In two cases an increased white-cell count was noted long after splenectomy, one of 50,000 at the end of four months, and one of 16,000 at the end of three years; no explanation is offered in either instance.

# IRVIN ABELL

## OPERATIONS

Primary splenectomy	83
Recovered	66
Died	15
Result not given	2
Detorsion and replacement followed later by splenectomy	2
Total splenectomies (deaths 15, mortality 17.6 per cent)	85
Detorsion and replacement (died, 1—mesenteric thrombosis)	5
Splenopexy alone (no deaths)	3
Exploration (closure 1, drainage 1—died)	2
	—
Total	95

Primary splenectomies were done in eighty-three. Detorsion and replacement were carried out in two cases, both of which later showed acute torsion and were then treated by splenectomy, making a total of eighty-five splenectomies, of which sixty-eight recovered and fifteen died with the result not stated in two, a mortality of 17.6 per cent. Detorsion and replacement constituted the only operation in five with four recoveries and one death, the latter due to mesenteric thrombosis. Splenopexy alone was done in three with no deaths and exploration alone in two, one with drainage and one without drainage, with one death. In the patients treated by splenopexy and detorsion with replacement classed as recovered, no follow-up as to the ultimate fate of the replaced organ is given. The operations which attempt to conserve the spleen when the organ has acquired a wanderlust and become the victim of a torsion must have a very limited scope. The circulatory damage sustained as a result of the twisting of the pedicle, the greatly increased size commonly noted in such organs and the insecurity of any known

## SIZE

By weight	53
By measurement	10
Not enlarged	1
Enlarged	11
Not stated	20
	—
Total	95

## Size by Weight in Grams

200-500	8
500-1000	13
1000-1500	10
1500-2000	8
2000-2500	7
2500-3000	3
3000-3500	2
3500-4000	1
4000-4500	1
	—
Total	53

## Size by Measurement

12x5x9 cm	1
19x9 cm	1
18x11x7 cm	1
21x15 cm	1
37x22x12 cm	1
16x11 cm	1
30x15 cm	1
25x18 cm	1
177x101x114 mm	1
5½x5 inches	1
	—
Total	10

## TWISTED PEDICLE OF WANDERING SPLEEN

method of replacement all argue against conservative procedures. The ease with which other tissues rich in reticulo-endothelial cells compensate for its loss invalidates any objection as to a loss of its function. In the light of these considerations splenectomy is to be considered the operation of choice.

The normal spleen varies greatly in size in different individuals and in the same individual under varying conditions. Its average weight is given as 225 grams and its average dimensions at ten centimetres in length, six centimetres in width and three centimetres in thickness. Of fifty-three of the present series whose weight was stated, but eight were under 500 grams, the remaining forty-five varying from 500 to 4,500. In ten in which the size was determined by measurement only, a corresponding increase in size over the normal is indicated. It is evident that circulatory change dependent upon the elongation of the pedicle with malposition induces in the wandering spleen a gradual enlargement aside from that resulting from malarial infection and acute torsion, while, as noted above, the latter accident causes an immediate enlargement due to the intense congestion.

### PATHOLOGICAL FEATURES

Infarction	2
Thrombosis of splenic vein with infarction	2
Old diffuse infarcts	1
Hæmorrhagic infiltration, with and without necrosis, rents and ruptures	17
Fibrosis	4
Enlargement, congestion, hepatization, no gross microscopical change	17
Chronic congestion with hyperplasia	4
Malarial splenomegaly	8
Necrosis with hæmorrhage—no stain	5
Chronic passive congestion	11
Pathology not mentioned	24
	—
Total	95

The pathology reported by the various observers, as far as it relates to the spleen alone, comprises nutritional changes varying from congestion to necrosis superinduced by mechanical interference with the splenic artery and vein.

Four specimens are mentioned as containing blood cysts of appreciable size, eighteen as showing thrombosis of the splenic artery or vein, or of both. One refers to a woman, with recognizable splenic tumor during pregnancy, who two weeks after normal delivery was seized with acute pain and brought to the hospital at the end of the seventh week following labor. Incision showed a cystic tumor from which fourteen litres of thick, brownish pus, sterile on culture, were removed. This was due to a necrotic spleen resulting from dislocation and twisting of pedicle. Recovery followed splenectomy.

In fifteen cases the presence of free fluid was noted in the peritoneal cavity, varying in amount from several ounces to six litres. It was described as colorless and yellow fluid, serum, hæmorrhagic serum, blood and blood-clots. Three of the fifteen showed fatal termination.

The pedicle has been described as of various lengths, the longest being ten inches, the largest compared in size to that of the fetal arm. In all the cases it has been noted as twisted and in sixty an estimate of the torsion given, ranging from one-half to six complete turns. The vessels have been described as thrombotic and as dilated, both artery and vein in some, the vein alone in others. In two the size of the vein was compared to that of the small intestine. In eight the tail of the pancreas is noted as being involved in the torsion, in all but one it being disengaged by detorsion and escape injury, in one it was resected with the pedicle without untoward result.

Seven cases are recorded as showing intestinal obstruction, three involving the small intestine, one the transverse colon and three the sigmoid. Two recovered, four died and in one the result was not stated. In the small intestine obstructions, the bowel was adhered to and caught in the twists of the pedicle. The transverse colon was adhered, kinked and compressed. The sigmoid showed volvulus from traction in one, adherence and kinking in one and adherence and compression occlusion in one.

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# ACUTE MASSIVE HÆMORRHAGE FROM DUODENAL ULCER

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THE statement is frequently made that "patients rarely bleed to death from duodenal ulcer" This gives the impression that one need not consider this possibility seriously, and that if bleeding occurs, spontaneous cessation can be expected Ulcers do bleed moderately without alarming sequelæ and many bleed severely with recovery of the patient On the other hand, we believe that the incidence of fatal bleeding in such cases is greater than commonly supposed Feeling that the type of ulcer patient who may bleed to death might be more accurately defined, and that with a better understanding of the situation the mortality reduced, we have undertaken a study of such cases occurring in the Massachusetts General Hospital in the past twenty years It may be added here that fatal hæmorrhage from the gastro-intestinal tract from causes other than duodenal ulcer are not included in this report

In the period of time covered by this study, 1,804 cases of duodenal ulcer have been treated in the wards of the hospital Of these, 628 either have a history of gross bleeding or have bled while under observation in amounts recognizable by macroscopical methods It is likely that a much greater percentage of all ulcer cases have bled some, and it is possible that all of them at some time during their periods of activity have bled slightly Those with known minor bleeding, 252 cases, have had no secondary anæmia and have responded to the usual medical treatment effective in a large percentage of the whole group There have been 176 cases classified as moderate bleeders inasmuch as sufficient blood loss had taken place to produce a reduction in red blood-cells to three million and a hæmoglobin below 70 per cent Most of this group have also temporarily, at least, responded to medical treatment Occasionally, we find a history of mild or moderate bleeding in previous years among those who have been classified as severe

In the severe group we have considered only those patients who have bled sufficiently to produce a marked secondary anæmia There have been 200 such cases In this discussion we are primarily interested in acute massive hæmorrhage and have divided the severe group into those who have bled gradually over a period of weeks, sixty-two cases, and those whose hæmorrhage has come with sufficient suddenness to produce prostration, shock and marked acute anæmia There have been 138 of these, 22 per cent of the whole number of bleeding cases Of this number, twelve have bled to death without operative interference and eight have been operated upon in a de-

# MASSIVE BLEEDING FROM DUODENAL ULCER

pleted state, none successfully The mortality, then, is 14·5 per cent in this group of sudden severe massive hæmorrhage

It must be added here for the sake of clarity that none of these patients was subjected to surgery until all hope had been lost for a spontaneous recovery

TABLE I

*Incidence of Severity in Bleeding Duodenal Ulcer*

	Cases	Per Cent
Minor	252	40·1
Moderate	176	28·0
Severe {	Gradual	62
	Sudden	138
	—	—
Totals	628	100·0

Since we do not wish to be misunderstood, we call attention to the fact that the scope of this paper is confined to the group of 138 cases of sudden severe massive hæmorrhage from duodenal ulcer How one deals with a bleeding ulcer in the quiescent state will not be taken into consideration at this time We must segregate these entirely different problems in our minds In the quiescent state we have a variety of courses from which to choose, but in 14·5 per cent of the acute massive group we are up against a situation which Balfour<sup>2</sup> has well stated is comparable to that of pulmonary embolism, in which embolectomy becomes justifiable if the patient is obviously dying

*Anatomy*—In nearly every fatal case we have been able to demonstrate at operation or autopsy the erosion of a large artery The ulcer has been on the posterior wall of the duodenum where it overlies the pancreas It may have started on the anterior wall or superior margin, involving the posterior surface secondarily At late operation or at autopsy one finds the entire posterior surface of the duodenum missing to the borders of the ulcer and the bed of the ulcer consisting of eroded pancreatic tissue Either at the superior margin or in the crater of the ulcer one finds a large exposed vessel with an opening of sufficient size to admit an ordinary probe During operative attempts to cope with this situation, blood spurts from the open vessel at an alarming rate

The gastroduodenal artery is given off of the hepatic or occasionally from the celiac axis as a separate branch It runs between the duodenum and the pancreas, dividing into the right gastro-epiploic and the superior pancreaticoduodenal The inferior pancreaticoduodenal comes from the superior mesenteric and the profuse anastomosis between these vessels behind the duodenum makes it impossible to control bleeding from any one of them without ligation of them all

In one of the fatal cases, not operated upon, a thrombosis was found in the gastroduodenal artery at autopsy, death having resulted from the flow of blood from the inferior vessels

The identity of the vessels at operation is so obscured by the surround-

ing inflammatory reaction that one can only hope to intercept them as the tissue about the ulcer is divided. Erosion into the pancreas may have extended sufficiently deep to expose an accessory pancreatic duct, and this in itself may play an important rôle in the further development of the eroded vessels and in the treatment of the ulcer.

*Age*—The most striking differential point between the cases of apparently the same severity on admission who spontaneously ceased to bleed, and those who bled to a fatal termination, is the average age. In the fatal group, this was 56.3 years and in those who recovered it was 41.8 years. Only two fatalities occurred under forty-nine years of age. One of these was a man of twenty-five who had pulmonary tuberculosis, was a morphine addict and died of hæmorrhage from a duodenal ulcer that had bled profusely on four previous occasions over a seven-year period. The other, a man of thirty-five, was operated upon in a depleted state three days after the onset of profuse hæmorrhage. He had bled moderately ten years before. This difference of approximately fifteen years between the fatal and the recovered group might be expected to be reflected in the chronicity of the ulcer. As a matter of fact, this is not well borne out, as in the recovered group the duration of symptoms was 7.7 years and in the fatal group 8.1 years—an average increase of less than five months. One must explain this lower mortality among the younger group on the basis of more elasticity of vessels and fewer complicating disorders.

In an effort to define the type of severe massive bleeding case that must be more seriously considered as a possible fatality, we found in the records twenty-four recovered cases that bled alarmingly enough while in the hospital to place in this class. On close analysis, we find only two of these were beyond our average age of 56.3 years found in the fatal group. The average age of these twenty-four cases was 43.5. In the whole group of 118 cases who recovered from sudden severe hæmorrhage there were only fourteen beyond the average age of the fatal group. Of these fourteen cases, three were females, which is relatively a very high proportion for this sex. That is to say, 23 per cent of women over fifty-six recovered, whereas only 10 per cent of men over fifty-six recovered. (Graph I.)

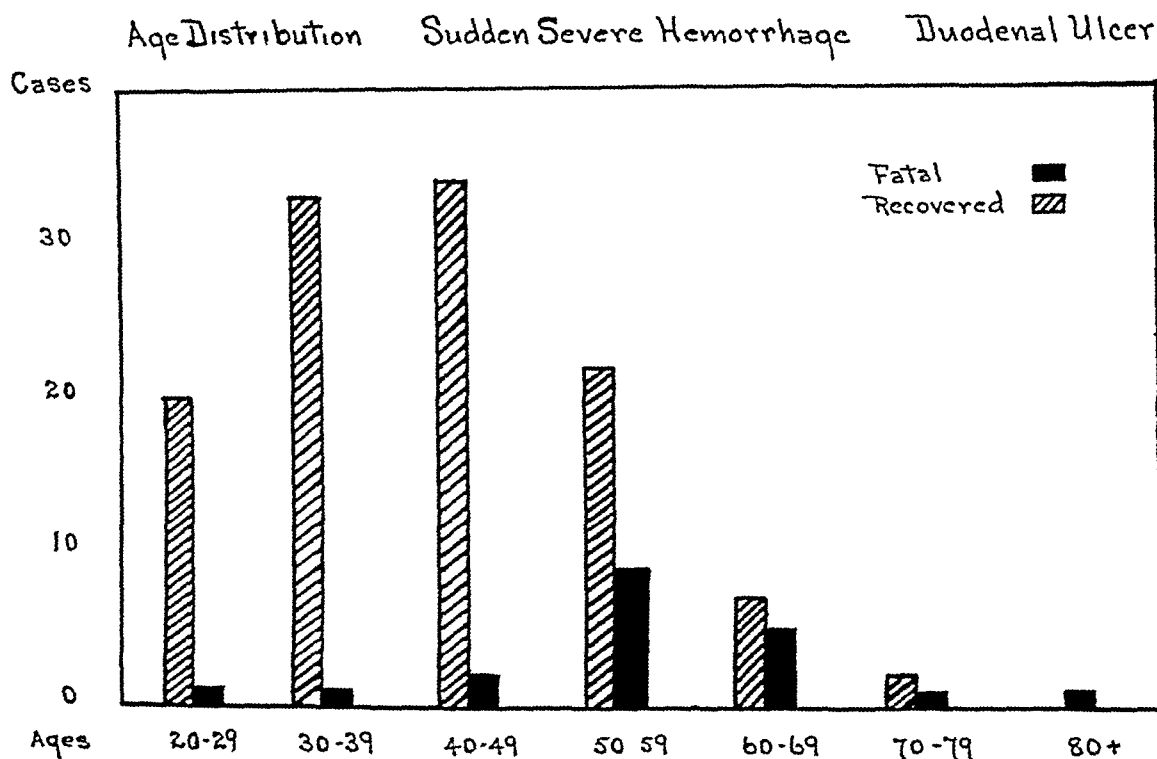
*Repeated Episodes of Bleeding*—It has been more or less commonly believed that patients would be more likely to recover from their first attack of severe bleeding than they would if there had been previous periods of bleeding. Inasmuch as 60 per cent of our fatal cases died during their first episode of bleeding, it is not safe to rely on the fact that no previous history of such attacks can be obtained. In the twenty fatal cases, twelve had not bled previously, seven had bled once before, and one died during his fifth bleeding attack. We refer to episodes of bleeding which may last several days and not to single hæmorrhages. Of those who recovered, seventy-eight had not bled before, twenty-five had bled once and fifteen had had two or more such attacks. The interval between hæmorrhages varied from four months to twenty-nine years. Of those who have had only one episode of

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severe bleeding, fifteen have gone five years, four ten years and three fifteen years or more without further bleeding. Some of these have been protected by surgical procedures done in a quiescent state.

*Time Interval Involved Between the Onset of Bleeding and Death*—It is interesting to note that in many instances the fatal cases lived several days after their first symptoms of severe massive hæmorrhage were manifested. The patient feels faint and either vomits a large amount of blood, or passes a loose stool filled with blood, or both. He may or may not have had previous warning. Many of the cases have known duodenal ulcers. Many of them have been under treatment and some have had previous surgery. The onset of bleeding may be the culmination of a return of symptoms that have been

GRAPH I



precipitated by a bout of drinking or a definite break in their medical and dietary régime. This may be their only bleeding, which rapidly subsides and leaves them with fewer symptoms than they had previously. Others may have little if any warning, the hæmorrhage being the first indication that all is not well. In the group who spontaneously cease to bleed there may be evidence of two or three periods of bleeding or only one in the first twenty-four-hour period, after which occult blood may be found in the stools for a few days, then they rapidly regain their lost blood so that in a period of three to five weeks they have entirely recovered from the episode.

Those who have fatal hæmorrhage may have exactly the same onset, and seem to be doing well from one to four or five days, only to repeat the profuse hematemesis or melena or both. The majority of the fatal cases have repeated periods of syncope associated with hematemesis or blood by stools in successive attacks with intervals of a few hours to two or three days. It is not always possible to ascertain by the degree of collapse, by the amount

of blood that is recovered from either external orifice, or by the grade of anæmia, whether a patient will fall into the class of spontaneous recovery or go on to a fatal termination. However, there are certain cases that pick up so rapidly after their first prostration that they can be fairly safely segregated from those whose balance may turn one way or the other. In our 138 cases of severe massive hæmorrhage, we believe that ninety-four may, in retrospect, have been predicted a better than average chance for recovery. In the remaining forty-four cases, one cannot make out from a record of their symptoms and condition at entry whether they would be likely to recover or die. We do know, however, that the twenty fatal cases lived in the hospital an average of 13.5 days after entry and lived an average of sixteen days after the initial onset of bleeding. One of them bled so rapidly to a fatal termination that radical surgery was impractical. Two had concurrent conditions contraindicating surgery. One was eighty-one years of age and probably could not have been successfully operated upon. However, there are sixteen cases left, some of whom might have been saved by immediate surgery if the fatal possibility could have been determined soon after admission to the hospital.

*Treatment of Severe Bleeding Duodenal Ulcer* —It is generally accepted now by a majority of clinicians that gross bleeding in duodenal ulcer is one of the chief indications for surgery. Some of these patients never have a return of bleeding, but many of them do, even after many years of quiescence. It also appears that bleeding ulcer cases are more likely to have recurrences of other ulcer symptoms than the average case on dietary measures.

Jordan and Kiefer<sup>5</sup> have reported from the Lahey Clinic a group of ulcer patients resistant to medical treatment and place bleeding as the most important factor in their failures. If we accept the fact that such cases should be considered surgical in a quiescent state it seems more reasonable to contemplate surgery early in certain severe bleeding cases. Finsterer<sup>4</sup> apparently subjects such patients to radical surgery as soon as the initial state of shock has passed. This has seemed too radical to most of us, as we all dread subjecting a patient to operation during an episode of severe bleeding. The mortality will of necessity be higher than similar procedures done in a quiescent state. On the other hand, if we are forced to operate after a patient has become depleted, a successful outcome will be rare.

It is our belief that a patient entering the hospital with severe massive hæmorrhage from known or strongly suspected duodenal ulcer should be looked upon as a potential fatality. Depending upon the age of the patient and the severity of their bleeding, we will usually be able, within a few hours, to determine whether or not spontaneous recovery can be expected. Both groups should be carefully watched by the medical and surgical services. Those cases who do not rapidly improve and those who have repeated attacks of syncope, hematemesis and melena should be carefully transfused. If they continue to bleed, a large transfusion should be given and immediate operation undertaken. Repeated transfusions may keep these individuals alive for several days but depletion is taking place all the time. It is also possible that

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further erosion into the pancreas may be going on. The earlier operative interference can be decided to be justifiable, after the initial state of shock has passed, the more likelihood there will be of a successful outcome. One may feel justified in a less radical operation in the early cases, but this must be determined after the ulcer has been exposed. The bleeding area must be attacked directly and hæmorrhage definitely checked, as palliative procedures are almost sure to fail in this group of patients.

*Transfusion*—Much has been said concerning the danger of transfusion in acute bleeding ulcer. An analysis of this situation has previously been reported by one<sup>1</sup> of us. There is little evidence that transfusion had any bearing on continued or repeated bleeding. Five cases died of hæmorrhage

TABLE II  
*Fatal Cases Operated Upon*

Age	Sex	Duration of Symptoms Years	Alcohol	Pain to Back	Previous Bleeding	Days Bleeding Pre-entry	Days in Hospital Pre-op	Transfusion	Type of Operation	Death
61	M	5	++++	0	0	1	3	0	Plication of duodenum A G E	3 hours post-op - hæmorrhage
35	M	10	++++	0	1 (10 yrs ago)	1	3	1	Duo opened, ulcer sutured - A G E	22 hours post-op - hæmorrhage
51	F	20	0	0	0	2	23	2	Antrum opened Deep sutures placed around ulcer P G E	10th day post-op - massive hæmorrhage
52	M	4	0	+	1 (2 yrs ago)	21	11	5	Bilroth II	17 hours post-op - hæmorrhage
58	M	10	0	0	0	3	3	2	Resection attempted	on table - hæmorrhage
49	M	12	++	+	0	3	16	1	Duo opened attempt to control bleeding	on table - hæmorrhage
67	M	6	0	+	1 (2 yrs ago)	3	29	7	Bilroth II	18 hours post-op - shock
54	M	$\frac{1}{2}$	0	+	0	6	5	6	Modified Polya Control of bleeding during operation	4th day Pancreatitis subdiaph abscess

without transfusion, having been in the hospital thirteen, ten, seven, five and one-half days, respectively, before death. Patients that bled out several transfusions in a period of from one to five days all resulted fatally whether operated upon or not. It is our belief that everything should be ready for transfusion, either matched citrated blood at hand, or a donor within the hospital, and blood given the patient only on his failure to hold his own with a systolic blood-pressure above 70 millimeters of mercury. If the pressure has fallen below this level, death may take place so rapidly that there is not time for transfusion. The blood should be given slowly in moderate amounts of about 300 cubic centimetres. If so done, there is no danger of rapidly elevating the blood-pressure. Many cases have responded well to this treatment with no further serious bleeding during the episode. After the patient is safely over the acute stage of hæmorrhage (five to seven days)



blood transfusion will materially shorten his hospital convalescence. Operation should be considered and undertaken in a large percentage of the patients who rapidly lose the benefits of transfusion (Tables II and III.)

*Surgery in the Depleted State*—Unfortunately, certain cases enter the hospital in a depleted state, and others, owing to mistakes in judgment, are allowed to reach a very precarious condition even after hospital entry. Under such circumstances we are forced to either look upon the situation as hopeless or to make some heroic attempt to save a life. Watchful waiting and late surgery have each been tried in the twenty fatal cases included in this study. Twelve have died without surgical interference. Four of these were justifiable either from the standpoint of complicating diseases, old age or from lack of

TABLE III  
*Fatal Cases Without Operation*

Age	Sex	Duration of Symptoms Years	Alcohol	Pain to Back	Previous Bleeding	Days Bleeding Pre-entry	Days in Hospital	Transfusion	Remarks	Death
58	F	15	0	0	1	3	35	1	Bled slightly for 1 mo then transfused	2 days later
63	M	10	0	0	1	? several	32	5	Entered for abd pain-G U serv Ulcer thought quiescent Cystotomy for stones	Sudden hemorrhage duod ulcer 2 wks post-op
81	M	1 day	0	0	0	1	4	1	Little improvement from trans Continued bleeding	2 days later
69	M	20	0	0	1	1	13	0	Not trans Op to have been done day of death	20 hrs after ba meal
54	M	5	+++	+	1	10	8	0	Op advised by surgeon Vetoed by physicians	Sudden decline No Transfusion
25	M	7	+++ morph	0	4	1	10	0	Bilateral Pulmonary T B	Sudden G I hemorrhage
49	M	10	+++	0	0	1	5 hrs	1	Arrived bled out Transf Bled out 2 hrs Diabetic	5 hours after adm
69	M	1	0	0	1	0	17	1	Severe bleeding on ward Transfusion	24 hrs after transfusion
51	M	8	+	0	0	0	9	1	attempt made to get him in operable state	Erosion of pancreaticoduod artery
54	F	0	0	0	0	0	49	3 x a day	Resection hemangio-endothelioma of colon	duo ulcer-hemorrhage
56	M	3	++	0	1	10	6	1	Transfusion Sudden failure from hemorrhage	Erosion of Pancreaticoduod artery
71	M	10	0	0	1	4	1	0	Arrived bled out	24 hrs after admission

time after entering the hospital. Eight were subjected to surgery in an attempt to stop the bleeding after all hope of spontaneous recovery had been abandoned. Two bled to death during the operation. Four died within twenty-four hours. One died of pancreatitis, subdiaphragmatic abscess and bronchopneumonia on the fourth day. One died of recurrent hæmorrhage on the tenth day.

If one of this group in a depleted state is going to be rescued by surgical measures, we must be prepared to meet the situation in a logical manner. Given an open large vessel behind the duodenum on an eroded area in the pancreas, one must be willing to obtain exposure and intercept the vessels that enter the ulcer outside of the ulcer bed. Attempts at controlling this type of bleeding by sutures, by cautery or by simple gastroenterostomy

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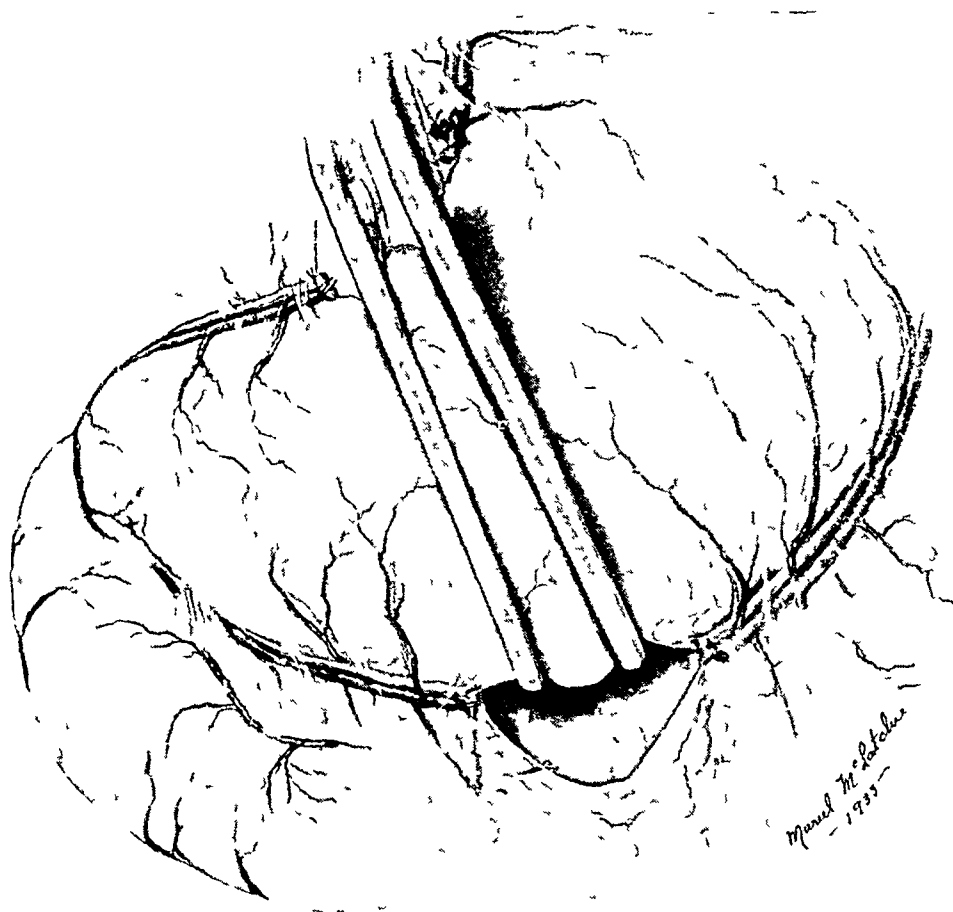


FIG 1—The stomach is divided between crushing clamps

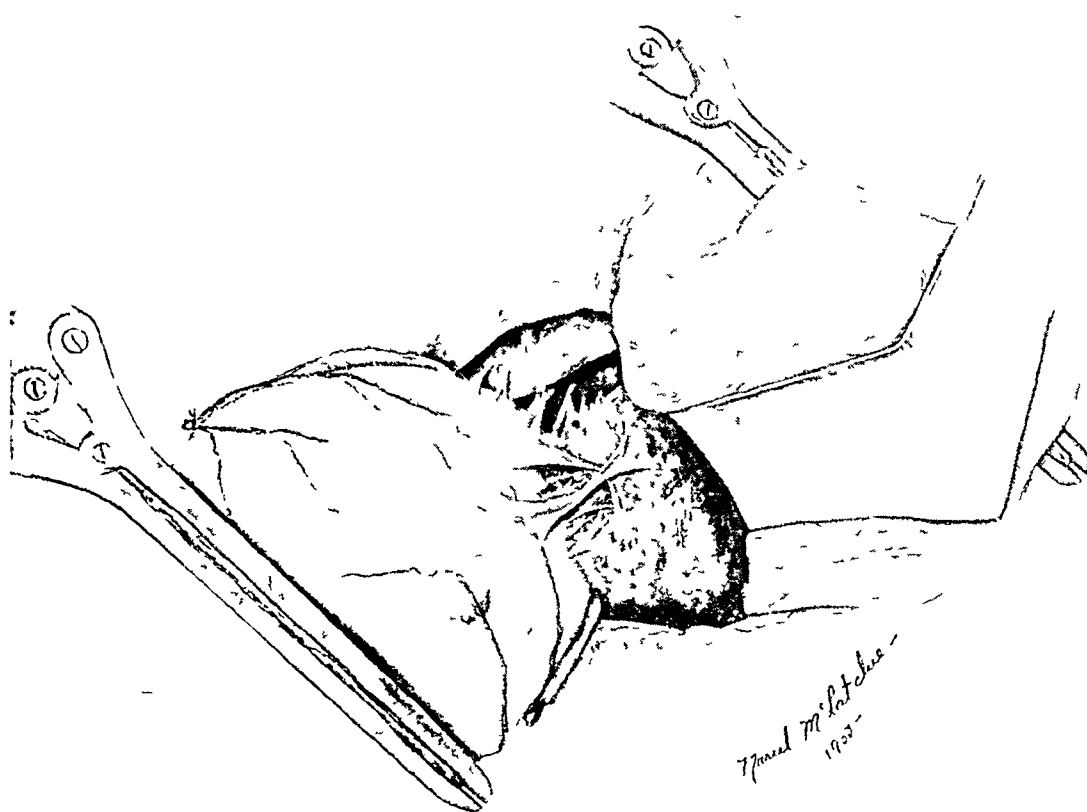


FIG 2—The distal segment is freed down to the adherent portion of the ulcer

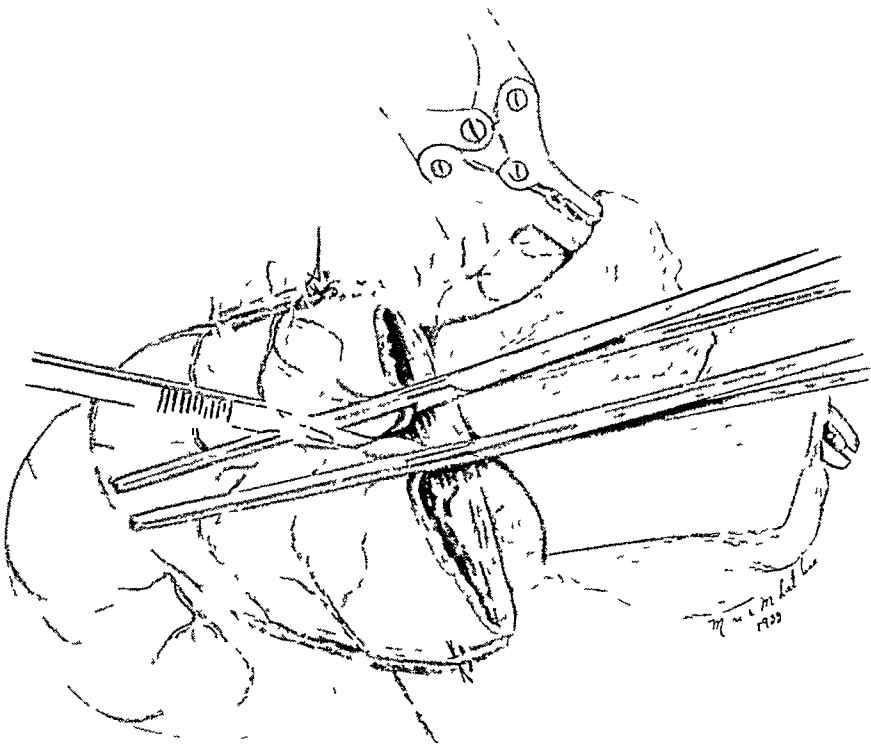


FIG 3—The anterior wall of the distal segment is opened through the pylorus

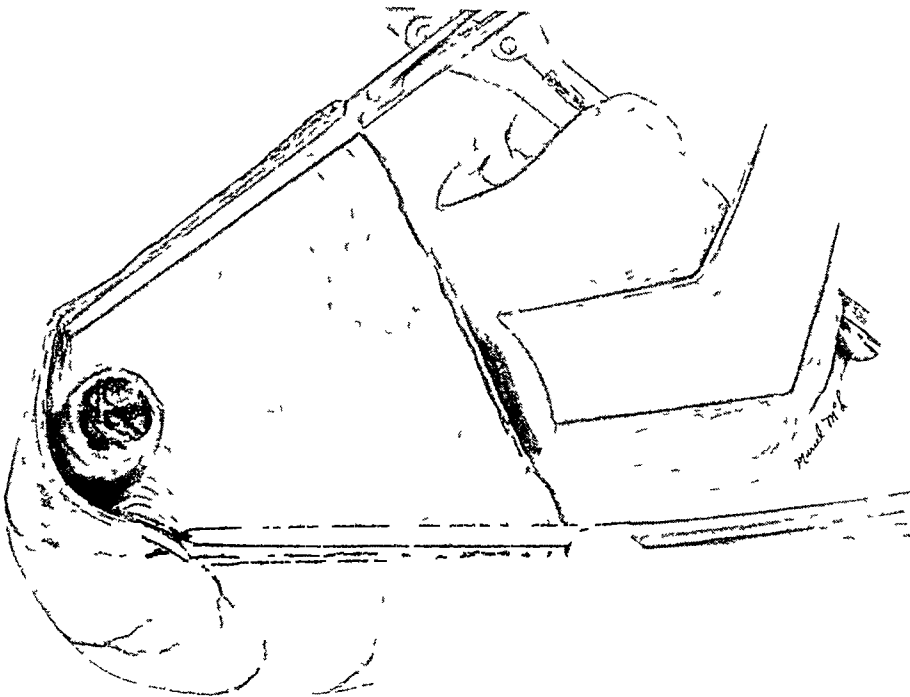


FIG 4—The ulcer is widely exposed

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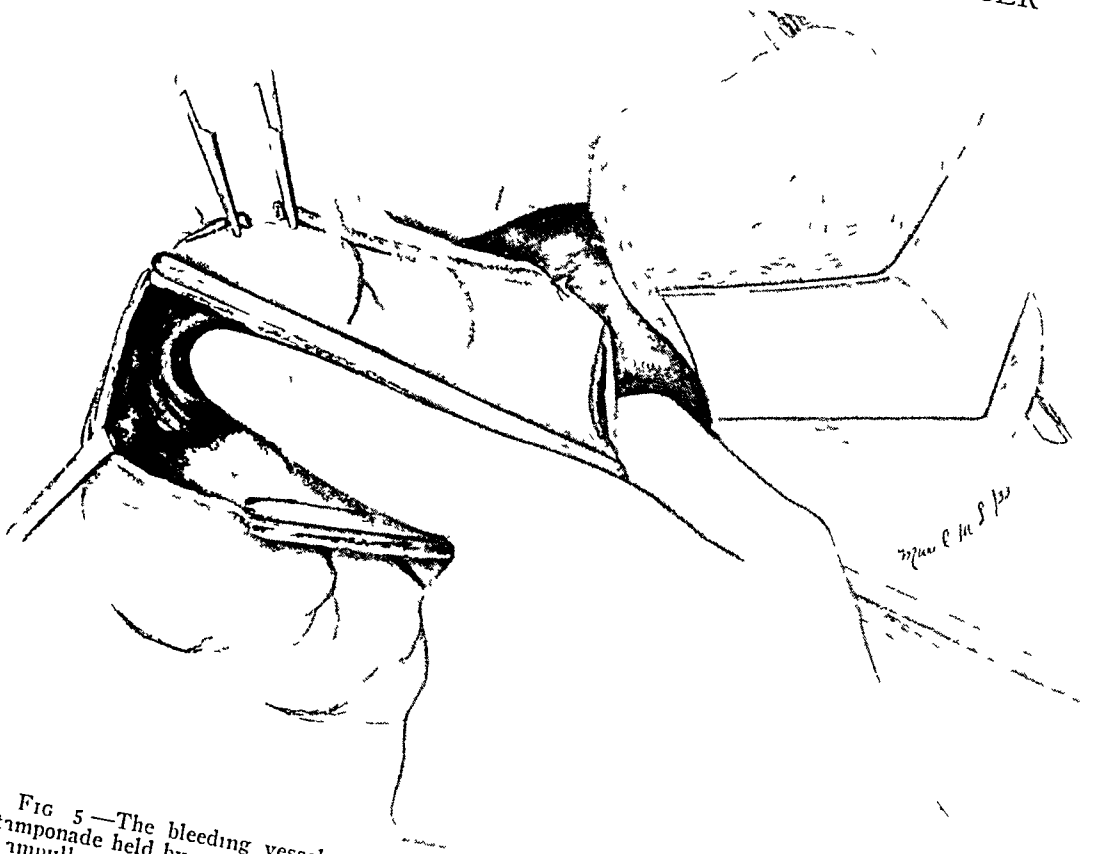


FIG 5—The bleeding vessel can be controlled by pressure of the operator's index finger. A tamponade held by an assistant is a second best method of control. Note the retractor exposing the impull of V. 121

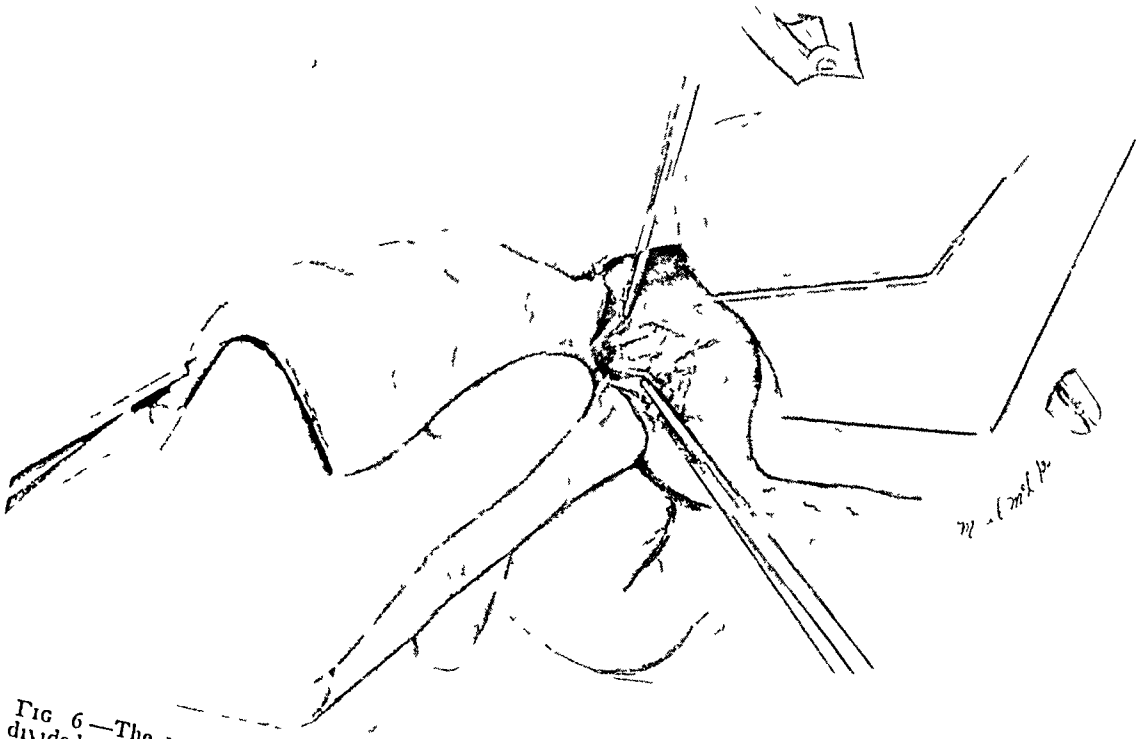


FIG 6—The vessels entering the ulcer area can be secured, as the adhesions about the ulcer are divided. It is important to avoid breaking into the ulcer area from behind—if the ulcer is to be inclosed as shown in Fig 8

without a direct attack upon the ulcer will probably fail In order to control the loss of blood during the operative procedure one may rapidly transect and free up the lower third of the stomach down to the ulcer (Figs 1 and 2) Then remove the distal clamp and open wide the anterior wall of

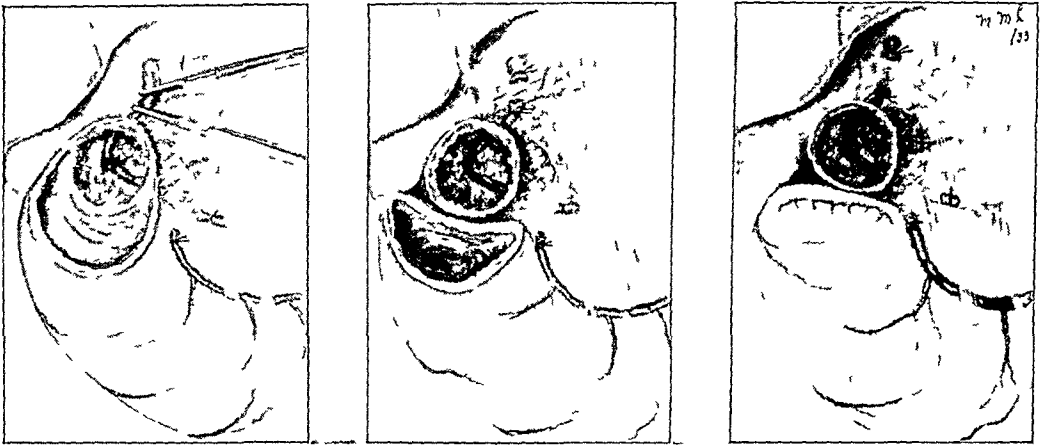


FIG 7—The ulcer can be left exposed if not too large and too deep A large deep erosion in the pancreas is a menace to leave exposed within the peritoneal cavity

the lower segment so that the ulcer is in clear view (Figs 3 and 4) Having done this the bleeding point can be kept controlled by a finger or tamponade (Fig 5) and the resection continued without further serious loss of blood The vessels entering the edge of the ulcer are intercepted as

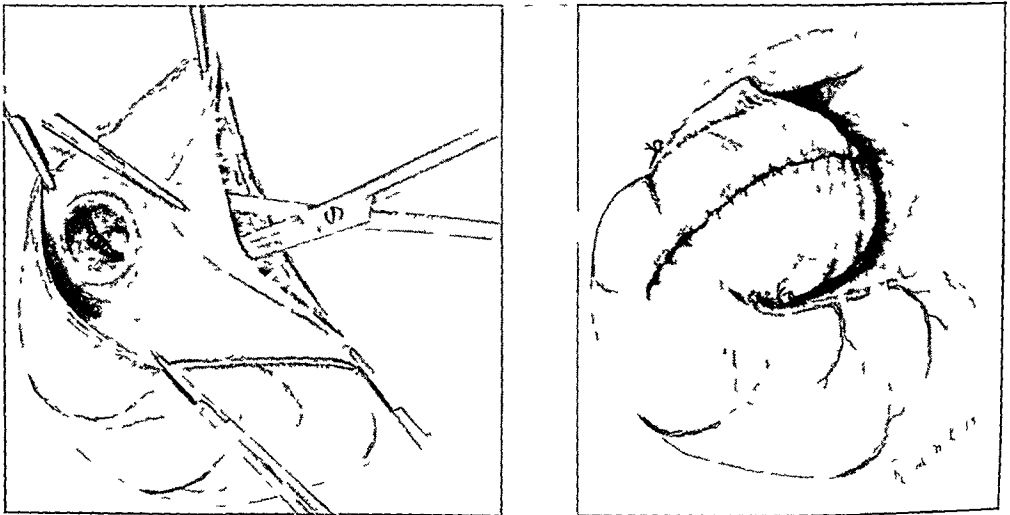


FIG 8—A method of enclosing the ulcer within the duodenum after the vessels have been secured from the outer area Part of the distal segment of the stomach has been discarded, leaving sufficient for easy suture The mucosa can be removed from the remaining antrum, to dispose of the acid activating cells

the inflammatory tissue is cut across (Fig 6) Having the hæmorrhage controlled one can place a retractor in the duodenum and ascertain the level of the ampulla of Vater If there is room to free the duodenum beyond the ulcer bed and allow a satisfactory turn-in, the operation is easily completed (Fig 7) If one is in doubt concerning this or if the erosion in the pancreas

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is of large size and sufficiently deep to have opened an accessory pancreatic duct, then a modified procedure can be done. A part of the elevated distal portion of the stomach may be eliminated, leaving a sufficient amount of the pre-pyloric region for easy suture. One can then suture the duodenum and stump of the stomach in such a way as to enclose the ulcerated area in the pancreas (Fig 8). If one is anxious to destroy the remaining activating area in the antrum, and the patient's condition permits, the mucosa can be removed from this region as suggested by Bancroft<sup>3</sup> before the closure is made. Anastomosis between the stomach and bowel may be made by the Polya or Billroth II method. That these procedures are practical in certain cases we have demonstrated. One patient, having bled for ten days and having had five transfusions, lost so little blood on the table that his condition actually improved during the operation. He lived four days and at autopsy we found considerable fat necrosis and a collection of seropurulent material above the liver. Here we felt in retrospect that the modified procedure enclosing the large ulcerated area in the pancreas might well have resulted in a successful outcome. In another severe case of massive hæmorrhage operated on in a quiescent state three weeks after the onset of bleeding, the modified technic was successfully carried out. Of course, there are difficulties in these procedures. The space between the superior margin of the duodenum and the liver is foreshortened, making it easy to damage the common bile-duct and other structures in this vicinity, but by working from the stomach side it becomes possible to intercept with comparative safety the vessels entering the ulcer area.

It is essential that one must plan this procedure carefully beforehand, as the average surgeon will have very few opportunities during his entire experience to use it. We believe that the operative failures in our group of cases are partially due to the fact that several surgeons are involved.

*Conclusions*—(1) It would seem from a review of our cases that duodenal ulcer patients who have recovered from a severe hæmorrhage should be subjected to surgery in a quiescent state, as the possibility of a persistence of symptoms is great and the incidence of future episodes of severe hæmorrhage is about 40 per cent. Spontaneous recovery is less likely with increasing age. Surgical procedures indicated in the quiescent group are not discussed here.

(2) About one-third of all our duodenal ulcers requiring hospitalization have gross bleeding. Over 3 per cent of all of our gross bleeding cases died of hæmorrhage. Our mortality in sudden massive bleeding from duodenal ulcer was 14.5 per cent, regardless of treatment.

(3) Age seems to be the most striking single factor in determining the possibility of spontaneous recovery. Death from hæmorrhage rarely occurs in patients under fifty.

(4) Individuals with acute massive hæmorrhage from duodenal ulcer should be carefully watched. If they are beyond middle age and do not show early evidence of complete cessation of bleeding, as indicated by a careful check of blood-pressure, stabilization of anæmia, rapidly clearing

stools, lack of hematemesis, disappearance of pain and tenderness, and rapid improvement in general condition, immediate surgery should be seriously contemplated

(5) Matched citrated blood should be kept in the refrigerator or a donor held in the hospital. This should be used quickly if there is a second collapse and before the systolic pressure falls below 70 millimetres of mercury. If there is a rapid loss of the benefits of this transfusion, a large transfusion should be given and the patient immediately operated upon. The less delay in operation on this type of patient, the better his chance of withstanding the procedure, due to the fact that his reserve is not entirely depleted. Transfusion, although a life-saving procedure and a useful adjunct to a successful outcome, will not replace all of the elements that the patient has lost over several days of bleeding and starvation. Individuals rarely recover if blood loss is sufficient to require five or six transfusions, especially if associated with starvation over a period of several days.

(6) Patients who continue to bleed should be expected to have a large open vessel, situated in an eroded area in the pancreas. A method of attack in such cases is described. It is our feeling that an operative effort should be made in these patients, unless there are overwhelming contra-indications to surgery.

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DISCUSSION.—DR FRANK H. LAHEY (Boston, Mass.) said that Doctor Allen has in his paper some of the figures which were compiled from the follow-up figures in the Lahey Clinic ulcer series in an endeavor to investigate how bleeding indicates that such ulcer patients will not do well medically. Doctor Kiefer in that clinic followed 800 cases of duodenal ulcer with this in view. Of a series of sixty cases that had had a history of one attack of bleeding, 40 per cent failed under medical treatment. In twenty cases in whom there was a history of two hæmorrhages, 85 per cent failed under medical treatment. Of those twenty cases that failed under medical treatment, recurrent hæmorrhage occurred in thirteen of the cases.

Therefore, they have come to believe that a history of two hæmorrhages previous to coming to the Clinic is indicative of probable failure under medical treatment. He felt very definitely that one can cut down this mortality of bleeding ulcers if one accepts two or more hæmorrhages as an indication that radical surgery must be done on these cases. He reported at the last meeting of the New England Surgical Society that their mortality from unoperated bleeding ulcers was 2 per cent. That is wrong because that included all of the cases that bled. Actually, if one takes the eighty cases that bled after they got into the hospitals, because the others had bled before coming in and so could not be counted, four died. So the danger of fatality from bleeding ulcers in the

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hospital is certainly 5 per cent That is a really serious mortality rate from this complication

DR EDWARD B BENEDICT called attention to the fact that four of these cases also perforated, three of them some time after a severe hæmorrhage, and one two years prior to it It is so frequently said that bleeding ulcers do not perforate and that perforating ulcers do not bleed that this incidence of 3 per cent perforation in severely bleeding ulcers is of some importance In most instances it probably means multiple ulcers, with bleeding from an ulcer of the posterior wall at one time, and perforation from an ulcer of the anterior wall at some other time In one case, however, the perforation occurred only four days after a very severe hæmorrhage

DR DANIEL FISKE JONES (Boston, Mass ) remarked that internists are holding onto the bleeding ulcers too long They are afraid to have them operated upon, and the surgeon is responsible for that, for it has been said by surgeons that cases of acute hæmorrhage should not be operated upon He thought that the value of transfusions has been overestimated by many They do not appreciate that with each transfusion a less good effect is obtained The third and fourth, if they come within a few days of the first and second, seem to have little or no effect He thought the rule made by the surgeons some years ago at the Massachusetts General Hospital to be a very good working rule The patient was to be seen by the surgeon, and if the patient had to be transfused a second time within forty-eight or seventy-two hours he should be transfused and operated upon immediately This may seem radical to some, but he was sure that they could save more patients by operation after a necessary second transfusion than they are saving at present by making a hard and fast rule that no patient should be operated upon for acute hæmorrhage

DR FREDERIC W BANCROFT (New York City) asked Doctor Allen in closing to tell the mortality of his operative cases He said 14 per cent of all cases

DR ARTHUR W ALLEN (Boston, Mass ) said in answer to Doctor Bancroft's question, all of these cases in this group died, operated or unoperated because they were all kept in the hospital until they had reached a stage where they were moribund before they were turned over to the surgeon

Of course, there have been a great many successful cases where the surgeon has been able to get hold of the cases early The mortality in those cases operated on early is about what it is for ordinary pylorotomy for ulcers



## PANCREATIC EMERGENCIES

By JOHN M T FINNEY, M D

OF BALTIMORE, MD

THIS communication has to do with those abdominal emergencies that have their origin in the pancreas. We shall, therefore, concern ourselves only with those affections of that organ which, upon occasion, may require immediate surgical aid. In reviewing the literature of diseases of the pancreas, in the preparation of this paper, we were impressed with the number and character of the communications on this subject that have been presented by Fellows of this Association, past and present.

For the sake of brevity, and because it would be quite out of place before this audience, I shall omit extended reference to the anatomy and physiology of the pancreas. It will suffice for our present purpose to call attention to a few facts that have a direct bearing upon the subject under discussion.

Only in recent years has the importance of the pancreas, physiologically, pathologically and surgically, come to be estimated at anything like its true value. This was due largely to its deep anatomical situation, its peculiar structure, the arrangement of its ducts and the fact that its double function was for so long a time not understood. Furthermore, the close relationship existing between affections of the pancreas and diseases of the neighboring digestive organs, especially of the biliary tract, greatly exaggerated the difficulties experienced in making a differential diagnosis between affections of these organs. In common with the ductless glands, of which it was formerly thought to be one, little attention was paid to the pancreas by the earlier anatomists and physiologists. Not until Wirsung, in the early part of the seventeenth century, discovered that it had a duct, did it begin to attract particular attention. This discovery made possible at least a partial explanation of its function. Langerhans early called attention to certain peculiarities in its anatomy, but not until recent years has the true significance of the histological structures which bear his name been fully understood. Of the organs that have to do with digestion, the pancreas is one of the most vital, since the substances secreted by it, both external and internal, are necessary to the well-being of the human organism—in fact, to the continuance of life itself. Scattered cases, however, have been reported where apparently the entire pancreas has become necrotic as a result of acute hæmorrhagic pancreatitis, and has been removed as a slough, without any untoward results, either immediate or remote. I have myself seen two such cases. The only satisfactory explanation of this phenomenon is either that all the pancreatic tissue was not removed, or the presence of accessory glands. There is abundant experimental evidence to prove that the total loss of the pancreatic secretions, as in the case of complete removal or destruction of the gland, is quickly fatal, whereas the long-continued loss of gastric juice, even the com-

plete removal of the stomach itself, or the complete blocking of the flow of bile, may all be borne for varying lengths of time without serious effect upon the animal economy

The majority of pancreatic emergencies may undoubtedly be classified under the head of acute pancreatitis, the mechanism of the production of which will presently be discussed. Let us, however, first direct our attention to certain other potential sources of trouble in the pancreas, which, upon rare occasions, may give rise to emergencies or near emergencies, necessitating prompt surgical intervention, *e g*, certain congenital anomalies, trauma, pancreatic calculi, cysts, pseudo-cysts, tumors, and even that interesting recently described condition known as hyperinsulinism, which may exhibit such alarming symptoms as to demand immediate operative relief

The occasional presence of certain anomalies should always be borne in mind, *e g*, accessory pancreas, single or multiple. They are usually found in the muscular walls of the stomach or jejunum. If situated at the pylorus, their presence may give rise to congenital hypertrophic stenosis. Hale reports such a case. Cystic or adenomatous tumors of the gland may rarely become pedunculated, and hence subject to twisting of the pedicle. I have had one such case where, owing to the extreme mobility of the tumor, a correct pre-operative diagnosis was not made.

The relationship of the common bile-duct to the head of the pancreas is not at all constant. It varies from a very loose attachment to passage through the substance of the gland for some distance. In rare instances, the duodenum itself may pass through the head of the pancreas and be completely surrounded by it. This anomaly may give rise, in the case of either acute or chronic pancreatitis, to a potential obstruction of the duodenum that may require emergency surgical relief.

Like other abdominal organs, the pancreas is subject to trauma, but, unlike most of the others, owing to its relative inaccessibility and the protection afforded by the bony skeleton and adjacent structures, it is not often that it suffers serious harm, except in the case of the severer types of crushing injuries, or in penetrating wounds. There are, however, to be found in the literature a number of cases in which the pancreas has been lacerated or even torn asunder, thus necessitating immediate surgical interference.

Owing to its vascularity, such injuries are accompanied by immediate evidences of hæmorrhage and shock, while the characteristic deleterious effects of the escaping pancreatic ferments upon the surrounding structures begin quickly to manifest themselves. In cases of severe trauma with or without an open wound, where inspection does not at once reveal an injured pancreas, the possible presence of this complication should be suspected, especially if excruciating pain referred to the upper abdomen, together with profound shock and other evidences of hæmorrhage, are present. The intensity of the shock and pain accompanying the trauma, as in the case of acute pancreatitis, are characteristic features of this condition. The examination of the urine may throw some light upon the question of possible pancreatic injury, as the presence of a mild glycosuria is always suggestive.

In the case of a penetrating or lacerated wound exhibiting the clinical picture just described, an immediate exploratory incision would appear to be indicated, the results of which should determine at once the remedial measures necessary. As a rule, little can be done other than to stop the hæmorrhage, which generally is quite profuse and, owing to the friability of the gland, quite difficult to control. Having accomplished this by ligature, suture or gauze packing, as may seem best, closure of rent with a few sutures and provision of drainage for the escape of the pancreatic secretion is indicated.

Among other rare conditions which provide potential emergencies, although seldom actually presenting them, may be mentioned calculi in the ducts of Wirsung or Santorini, or even in the ampulla of Vater. These may give rise to symptoms somewhat analogous to those commonly associated with biliary calculi. The extreme rarity of pancreatic calculi is responsible for the fact that the possibility of their presence is rarely given due consideration in the differential diagnosis of acute abdominal emergencies. There seems to be no distinctive clinical picture upon which to base a diagnosis. The X-ray may be helpful, but here again it is difficult to distinguish with certainty between pancreatic calculi and those of biliary origin. The presence or absence of jaundice is too uncertain to be of any great diagnostic value. A study of the reported cases, including one of our own, seems to show that, beyond the deep-seated, boring character of the pain, the absence of severe nausea and vomiting, as compared with that usually met with in biliary calculi and acute pancreatitis, nothing very characteristic is to be noted. The pain, starting in the epigastrium, radiates rather to left side, perhaps, than to right, as in the case of gall-stones. Evidence of pancreatic deficiency may be observed on examination of stools. Diagnosis, if made at all, is usually arrived at by a process of exclusion. Removal of the stones is, of course, indicated. This is accomplished through incision into the body of the pancreas. Drainage of the biliary tract, or removal of the gall-bladder, is also indicated.

Pancreatic cysts, although of relatively infrequent occurrence, may arise from a variety of causes, which we will do no more than mention here—congenital, proliferation, adenoma and carcinoma, hæmorrhagic, dermoid, hydatid, retention and pseudo-cysts. It is not, however, so much the nature of the cyst that is of importance clinically, as its size, relationship to surrounding structures and its liability to certain accidents. It is these secondary characteristics rather than the primary cause that are of surgical significance. The cause of the sudden enlargement frequently noted in these cysts is usually due to hæmorrhage. This in itself may give rise to urgent symptoms—pain, nausea, vomiting, and, in the case of severe hæmorrhage, symptoms associated with loss of blood. Trauma is a very important factor in the etiology, especially in the case of pseudo-cysts. The diagnosis is not always easy, since it must be differentiated from other cysts having their origin in the neighboring organs. Pancreatic cysts are observed more often in the third and fourth decades of life, and more frequently in women. Often there is to be obtained a history of previous trauma. Even before the appearance of a tumor, there may be vague gastro-intestinal disturbances. As the growth enlarges, pres-

sure symptoms and increasing pain, indigestion, obstruction, rapid loss of weight and jaundice, some or all of them, may make their appearance. The tumor presents in the mid-epigastric region, and since it has its origin usually in the body or tail of the gland, is found slightly more often to the left. Its outline is usually symmetrical and elastic, and it may fluctuate. Imperative indications for operation are massive hæmorrhage from erosion of vessels in the cyst wall producing sudden enlargement of the cyst, accompanied by severe pain and possibly collapse. The operation consists of enucleation where possible, marsupialization, or drainage by the most convenient avenue of approach. The prognosis, on the whole favorable, depends largely upon the type of cyst and the underlying pathological factors.

One of the rarer pancreatic emergencies is duodenal obstruction resulting from tumor of the head of the pancreas, usually carcinoma. The chief complication resulting from this condition is, of course, obstruction to the common bile-duct, with the classical symptom-complex described by Courvoisier, and bearing his name, for which cholecyst-gastrostomy is usually indicated. The duodenum, however, owing to its intimate relationship to the head of the pancreas, may share with the common duct in the resulting obstruction. A number of such cases have been reported. In one of my own, I found it necessary to do both a cholecyst-duodenostomy, which I found I could do as easily as a cholecyst-gastrostomy, and, after nearly two years' interval of complete relief, it became necessary to do a hurried gastro-enterostomy, because of obstruction of the duodenum, due to the advancing growth of the tumor in the head of the pancreas. Obviously, this type of obstruction is seldom met with, and when it does occur, is usually gradual in its onset. In rare instances, however, as in my case just referred to, the obstruction may present sudden and grave symptoms sufficient to assume the character of an abdominal emergency. The clinical picture, of course, is that of a high duodenal obstruction. The diagnosis presents no real difficulty. The immediate relief is usually satisfactory, but, owing to the nature of the primary cause, the ultimate prognosis is bad.

As indicated at the beginning of this paper, acute pancreatitis furnishes the most frequent and important pancreatic surgical emergency. Its etiology has given rise to much discussion and animal experimentation. The consensus of opinion seems to be that, while it may rarely be found following trauma, or associated with various infections, typhoid fever, appendicitis, influenza and mumps, it owes its origin chiefly to the presence in the pancreatic ducts of a chemical substance or substances which have the property of activating certain ferments normally present in the pancreatic secretion. The chief point in the discussion is the special mechanism by which this is accomplished.

As far as can be ascertained, the process is substantially as follows, and is based directly upon the anatomical relationship of the pancreatic ducts to the common bile-duct and its outlet into the duodenum. Subject to certain variations, the ducts of the pancreas known by the names of their distinguished

discoverers, the ducts of Wirsung and Santorini, anastomose with the common bile-duct through a short common channel, the diverticulum of Vater, which in turn is also subject to certain variations, or it may be entirely absent. The significant feature of this arrangement is the fact that, under certain conditions, for instance, a spastic contraction of the sphincter of Oddi, as insisted by Archibald, or the presence of a small calculus in the diverticulum, as demonstrated by Opie in Halsted's case, its orifice may be so obstructed as to convert the two ducts into a common and continuous passage through which the bile, possibly infected, or mixed with intestinal contents, may be forced backward into the body of the pancreas. The most important factor in bringing about the resultant destructive effect upon the pancreas, namely, the rapid œdema, hæmorrhage and subsequent necrosis, which occurs almost immediately, is the bringing together within the body of the gland a mixture of pancreatic juice which contains, among other active ferments, trypsinogen, and certain activating substances, such as bile, whether infected or not, and calcium, which is present in tissue exudates and blood-plasma. As Archibald has pointed out, the pathological process is primarily a chemical necrosis, with the inflammatory changes purely secondary.

In this connection, I wish to report a series of thirty-two cases of acute pancreatitis that have been observed in the Johns Hopkins and Union Memorial Hospitals in Baltimore. I am indebted to Dr W F Rienhoff, Jr, for the collection and classification of the Johns Hopkins cases, and to Dr J M T Finney, Jr, for a like service in connection with those of the Union Memorial. In analyzing these two groups, and comparing them with similar series of cases reported by other observers, now aggregating a number sufficiently large from which to draw fairly definite conclusions, certain rather striking facts at once become evident. First, the comparative infrequency of the condition is worthy of note. In the Johns Hopkins, from 1889-1932, out of a total of 78,000 admissions, only eighteen cases of acute pancreatitis were observed. In the Union Memorial, from 1920 until 1933, there were fourteen cases out of a total of 40,350 admissions, giving a total of only thirty-two cases of acute hæmorrhagic pancreatitis out of 118,350 consecutive admissions in two large general hospitals. It is, of course, possible, indeed highly probable, that other cases were not recognized, in view of the rather surprisingly small number in which a correct pre-operative diagnosis was made. This latter fact is perhaps not so surprising after all, for the very infrequency of acute pancreatitis renders it liable to be overlooked when it does occur. The close association between the pancreas and the other organs of digestion, and the masking of its symptoms by those of various disorders of neighboring organs which closely simulate them, tend still further to confuse the diagnostic picture.

An analysis of the various case histories in our series shows that the outstanding symptom was pain of sudden onset, and described as deep-seated and agonizing in character, which followed, as a rule, a heavy meal. It was present in every one of the thirty-two cases (100 per cent). In the vast majority of cases, the pain was referred to the epigastric region, just

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below the tip of the xyphoid cartilage, possibly somewhat to the left of the mid-line. Rarely was the pain referred to the back or to the right side. Tenderness and muscle spasm, while noted in a few cases, were not a marked feature. Next in frequency came nausea and vomiting, with a distressing hiccough, profuse sweating, great prostration and shock, which were present in twenty-eight cases, or over 90 per cent. Jaundice was observed in twelve cases, or in over 36 per cent. Cyanosis, the symptom upon which Halsted laid such stress, was noted in only five cases, and a palpable mass was to be made out in only three cases.

There was a history of previous affection of the biliary tract of some form in over 40 per cent of cases. The leucocyte counts averaged consistently high, varying from 12,000 to 40,000.

At the operation, a serosanguineous exudate was found present in the abdominal cavity in seventeen cases, or over 52 per cent. Fat necrosis was observed in twenty-four cases, or over 76 per cent. These percentages conform very closely to those given in other published series. The mortality rate for the series was 37.2 per cent, that for women 25 per cent and for men 50 per cent, which bears out the idea of relative immunity to abdominal infections generally believed to be enjoyed by women over men. The general average of the cases reported shows that the sexes were about evenly affected, although in our own series the women slightly predominated.

In the light of the quite definite clinical picture of acute pancreatitis thus presented, it seems rather strange that it should not have more often been recognized before the abdomen was opened. To be sure, as has already been intimated, the picture is apt to be obscured by a history of symptoms suggestive of certain other acute abdominal affections—acute perforating ulcer of the stomach or duodenum, gall-stone disease, intestinal obstruction, acute appendicitis, renal colic, ruptured ectopic pregnancy, diaphragmatic pleurisy, to which should be added certain cases of acute poisoning, and, strangely enough, certain cardiac conditions, such as coronary thrombosis or rupture of the left ventricle, which may at times present a clinical picture almost indistinguishable from an acute abdominal crisis.

From this recital of pathological conditions, to which consideration must be given in making a differential diagnosis, the difficulty in reaching a correct conclusion becomes at once apparent. If, however, in approaching a case exhibiting symptoms of an acute abdominal crisis, one will be sure to bear in mind that acute pancreatitis, even although of relatively infrequent occurrence, has always to be reckoned with, one will be much less likely to overlook it.

Since early recognition of acute hæmorrhagic gangrenous pancreatitis is of prime importance, and since in the majority of cases the clinical picture is, as we believe, sufficiently clear-cut to allow of its prompt recognition if sufficient care is taken in working up the case history and physical examination, let us review briefly some of the more characteristic of the clinical signs of this emergency, lest we forget. The most constant and distinguishing

feature of acute pancreatitis is the sudden agonizing character of the abdominal pain and its persistent reference to a point just below and possibly to the left of the tip of the xyphoid cartilage. Add to this the profound prostration, the persistent nausea and vomiting, the absence of marked tenderness and board-like rigidity of the abdominal muscles so characteristic of acute perforations of the hollow viscera, the occasional presence of a palpable mass, slight glycosuria and the history of previous attacks of supposed biliary troubles. Given this particular clinical syndrome, the possibility of the presence of acute pancreatitis should at once suggest itself.

In considering operation upon the pancreas, there are certain characteristic features peculiar to this organ that must be borne in mind by the surgeon—since they tend to limit his field of activity—for instance, its comparatively difficult approach, the friability of its tissues, its anatomical structure, its relationship to neighboring organs, the size, number and thin walls of its vessels, which greatly increase the risk of hæmorrhage and also the difficulty in its effective control. Then, too, the digestive action of the pancreatic secretions and their irritative effect upon the peritoneum, fat and other structures, especially their digestive action upon adhesions, which are the principal safeguards against the spread of peritoneal infection, will unfavorably influence the end-results of surgery. While the truth of the foregoing statement is undoubted, it is also a fact that the overemphasis, perhaps, placed by Mikulicz and other earlier observers upon the dangers attending pancreatic surgery was largely responsible for the delay in its development and the rather widespread impression among surgeons generally that the pancreas constituted a sort of *'nolle me tangere'* in surgery. This impression, which undoubtedly did materially retard the development of pancreatic surgery, has, owing to increased knowledge of the subject, been largely dissipated, and the pancreas now takes its place among other structures of the body as quite amenable to properly controlled surgery. There still remains among surgeons a difference of opinion as to the best treatment for acute pancreatitis. The chief point at issue is whether or not the capsule and the tissues of the gland itself should be incised. The operation of choice in our series was evacuation of the bloody fluid free in the abdominal cavity, with exposure of the pancreas either through the gastrocolic or gastrohepatic omentum, as seemed best. In some cases, the capsule was incised, in others not. So far as the results were concerned, there seems to have been little choice as to whether or not incision into the gland was employed. No cases of very troublesome hæmorrhage following incision were encountered. In every case, free drainage by tube or gauze wicks, or both, down to the affected gland was provided. Some irritation of the wound edges and surrounding skin, due to the digestive action of the escaping pancreatic secretion, was observed, but the free application of lanolin to the surface of the skin about the edges proved very efficacious in allaying the irritation. The drainage tract healed fairly promptly, as a rule.

Contrary to what one would naturally expect, following such an extensive destructive process as acute hæmorrhagic gangrenous pancreatitis, relatively few late ill effects therefrom have been observed. Perhaps the most surprising

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fact is the relative infrequency with which diabetes mellitus has developed following wide destruction of pancreatic tissue. Slight transitory glycosuria has been reported fairly frequently in the acute stages, which, of course, means that the internal secretion is at first somewhat disturbed along with the external, but the tendency in either case is toward a gradual disappearance of the resulting unfavorable symptoms. A few cases, however, of persistent severe pancreatic dyspepsia have been reported as well as an occasional case of diabetes mellitus. Recurring attacks of acute pancreatitis are rare, although such have been reported. Perhaps the most common residual condition observed following acute pancreatitis is the chronic form, which, in turn, may give rise to certain well-recognized disturbances, discussion of which is beyond the bounds of this paper.

*Summary*—(1) The chief pancreatic emergency requiring surgery is acute hæmorrhagic pancreatitis.

(2) It is primarily of chemical rather than of bacteriological origin.

(3) In view of the quite characteristic clinical picture presented, a correct pre-operative diagnosis should more often be made.

(4) Surgery offers the best chance for recovery, but even when early applied, the results leave much to be desired.

## BIBLIOGRAPHY

In order to avoid unnecessary repetition, anyone interested in the Bibliography of the subject is referred to the very full lists of recent contributions appended to the excellent articles by Speese. Nelson's Loose-Leaf Surgery, vol. v, and Archibald Lewis's Practice of Surgery, vol. vii.

*DISCUSSION*—DR JOHN DOUGLAS (New York City) remarked upon what Doctor Finney had spoken of as acute pancreatitis but for which he had given reasons for having it called acute pancreatic necrosis. It is a condition of such rarity that one man very seldom has an opportunity to see a sufficient number of cases to form any definite conclusions. For this reason, during the last winter he had reviewed the cases which had occurred in St. Luke's Hospital during the past fifteen years. Curiously enough, the number was thirty-two, exactly the same number on which Doctor Finney reported.

In reviewing this group of cases, one is impressed very much by the extreme difference in the pathology which is described in the histories of the cases, and also by the difficulty in correlating the pathology in the pancreas with the pathological condition in the biliary system. Many of these cases divided themselves and presented three very distinct groups, although after looking them all over carefully it was very difficult to arrive at any definite conclusions.

In the first group, one was impressed by the large number of patients who gave a definite history of previous attacks. Usually these symptoms were diagnosed as severe biliary attacks or mild biliary colics, but in other cases where the pain was referred to the epigastrium it would be apparent that there was a real attack of pancreatic necrosis in some degree. In one case, where the patient died, the autopsy showed all the evidence of a previous attack.

One thing which was of particular interest in another group was the patients who had been operated on, and some operative procedure done either to the biliary system or drainage of the pancreas region instituted. These patients improved and were sent out either as not entirely healed or as cured. A very great percentage of these cases returned at various periods of two weeks to eight years with a subsequent attack of either pancreatic necrosis, from which they subsequently died, or were re-operated on and perhaps recovered, or with some type of pancreatic cyst.



That brings up the relationship of the etiology of the pancreatic cysts. I believe a large percentage of cases of pancreatic cysts are subsequent to an acute attack of pancreatic necrosis.

One patient at operation had a small amount of thickening in the pancreas, a moderate amount of fat necrosis, and nothing pathological in the biliary system. He was sewed up without being drained and within seventeen days he developed a cyst in his pancreas which when opened contained a quart of fluid. Another patient was operated on for acute pancreatic necrosis and subsequently had three attacks of pancreatic cyst, two years apart. In the first and third the cyst was drained and in the second attack the cyst subsequently subsided without operation. Another case came back three years after operation for acute pancreatic necrosis with a calcified area in the pancreas which was obviously a cyst.

The third group of cases was the most interesting of all. There was a considerable percentage of these cases operated on with a diagnosis of stone in the common duct, cholelithiasis or cholecystitis. At the time of operation for the gall-bladder lesion there was always some degree of pancreatic involvement. Very frequently nothing was noted but that the pancreas was hard and thickened and in some cases swollen to two or three times its normal size. In all of these cases there was fat necrosis present. In a very considerable number of cases notwithstanding the fact that the gall-bladder was drained, those patients went on and died and at autopsy there was a very marked hæmorrhagic necrotic disintegrated condition of the pancreas. That happened regardless of what we consider the proper treatment of pancreatic necrosis, the drainage of the biliary system being instituted, and demonstrates that the condition can progress and cause death. That leaves a question as to what we should do in regard to drainage of these cases, and in carrying out this same thought, if this method of biliary drainage is not the proper thing to do and is not effectual, then our treatment of acute pancreatic necrosis is wrong. But one case was particularly illuminating. Drainage of the gall-bladder had been done, and the patient improved until at the end of three weeks drainage stopped. The patient had another acute attack and by renewing the drainage she rapidly improved and recovered.

There were two cases reviewed which were not included in the series. They were cases of annular pancreas. In one case, which was operated on by Doctor Mathews, there was an obstruction of the duodenum. In the second case there were signs of chronic pancreatitis with the development of jaundice. That patient got well with the drainage of the common duct.

DR CARL EGGERS (New York City) reported eleven cases of acute pancreatitis that had been under his care. One of them was diagnosed as probable cholelithiasis, one as resting between perforated ulcer and acute pancreatitis, and the other nine cases were diagnosed as probable pancreatitis, or secondary cyst.

In considering these cases with a view to reaching a diagnosis he had been impressed by the severity of the symptoms as compared with absence of physical signs.

Intense, often excruciating epigastric pain, associated with almost constant vomiting and slight fever, have been the outstanding symptoms. There is moderate leucocytosis. On examination one finds marked tenderness but practically no rigidity. These signs aid one in differentiating the condition from a perforated ulcer and cholecystitis. The former gives board-like rigidity and the latter has localized tenderness not extending across the upper abdomen as in pancreatitis.

Five of the patients succumbed to the condition, one without operation. Death seemed to be due to shock and the severity of the toxæmia in four cases, while the fifth was due to exhaustion, hæmorrhage, and perforation of the stomach after prolonged drainage of a secondary pancreatic cyst with necrosis of the gland.

The six patients who recovered were operated on. Drainage of the peripancreatic

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tissue through the gastrocolic omentum was instituted. If the condition of the patient warranted it, one treated the associated gall-bladder disease at the same time.

Great interest attaches to the etiology of this condition, and although a great deal has been learned about its clinical manifestations and about associated lesions, we are still in doubt about the exact etiology. It seems in some way connected with biliary-tract disease, and accumulated evidence indicates that the process begins in the pancreatic-duct system and from there invades the parenchyma. It is probably not primarily an infection, but rather a chemical process. In all cases that he had operated on early, cultures were made of the peritoneal fluid, of the retroperitoneal exudate, and at times also of the gall-bladder. In every case the cultures were negative.

DR MAX BALLIN (Detroit, Mich.) mentioned a case demonstrating, he believed, a novel way of handling one of these pancreatic emergencies. A middle-aged woman had had fairly typical gall-stone colics for about two years. Two months before the operation to be described she had an acute attack which, no doubt, was a pancreatitis. Two months after this attack a tumor mass was felt in the upper part of the abdomen, smooth, fist size, in the epigastrium, mostly covered by the costal arches. Gall-stones with pancreatic cyst was the probable diagnosis. On operation there were found a gall-bladder with stones and, besides, a round, two-fist size tumor mass, seemingly belonging to the posterior wall of the stomach. In spite of the previous diagnosis of pancreatic cyst, at this time the impression of a benign tumor of the posterior gastric wall (myoma or something similar) prevailed. The stone-containing gall-bladder was removed first and further procedure as to the tumor decided upon. The tumor was adherent to the liver and the whole stomach was right over it so that the usual access through the gastrohepatic ligament could not be followed. Also the route through the gastrocolic ligament was not feasible for exposure of the mass. So, more for exploration as to the nature of the mass than anything else, a transgastric route was decided upon and the anterior wall of the stomach opened by a two-and-one-half-inch incision. The interior of the stomach was normal, the tumor did not originate in the posterior wall of the stomach but was adherent to it. Now we opened through this incision in the stomach also its posterior wall by a vertical incision and readily got to the tumor adherent broadly to the posterior wall of the stomach. It was so dense that it was still doubtful whether it was a soft tumor or a cyst. We tried to dissect it from the gastric wall on a chance of getting the tumor or cyst out. It soon broke and emptied about half a liter of brownish fluid with cholesterol crystals as from a hæmorrhage. Evidently it was a pancreatic cyst, also a large thumb-size pancreatic slough followed, as we have all seen before in pancreatitis. This drainage (slough and fluid) was obtained through the stomach without soiling the peritoneum and we decided to make the drainage permanent, suturing the incision in the cyst with interrupted catgut all around to the incision in the posterior gastric wall. The anterior gastric incision was closed by two rows of catgut and linen sutures.

This was done three months ago and it may be a little early to report on it, but so far the cyst has not refilled (X-ray check-up) and no untoward result has followed from the pancreatic secretion going through the stomach. If this transgastric method of draining a pancreatic cyst proves feasible in other cases it may be a way of overcoming the faults of the present methods of draining through the abdominal wall, namely, the irritation of the skin caused by pancreatic drainage and the necessity of keeping such drainage open, often for years, to avoid recurrence of the cyst.

Only one similar technic is mentioned in the literature in a case of a persisting pancreatic fistula of such a cyst drained through the abdominal wall and causing a great deal of discomfort by irritation of the skin (J Cathala and J Seneque *Pancreatic Fistula Cured by Pancreaticogastrostomy*. *Presse Med*, vol xxxviii, p 1534, November 12, 1930). The authors implanted the whole fistulous tract into the stomach without ill results and with complete relief. Our patient gained twenty pounds and is apparently well at present, without indigestion.

# THE ACUTE GALL-BLADDER AS A SURGICAL EMERGENCY

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UNTIL recently, the prevailing surgical opinion has certainly been opposed to prompt operation as a method of choice in dealing with acute lesions of the gall-bladder, and probably the prevailing opinion now is still so opposed. But this view is by no means unanimous. As long ago as 1923, Walton<sup>1</sup> urged the wisdom of early surgical interference, rather than delay, in handling acute gall-bladder disorders, and in the last few years other voices have been raised to the same purpose. The present writers share this minority view and this paper is intended to offer reasons for it. Before advancing such reasons, it may be well to present a brief summary of certain of the notable publications on the two sides of this question.

As representing German opinion of the date of 1923, Enderlen and Hotz<sup>2</sup> advocate postponement of operation until the interval and feel that early operation is indicated only by progressive changes for the worse. These authors advance statistics to show that the mortality of operation performed during the attack was double that performed during remissions. They operate if empyema is suspected and usually do a cholecystectomy. They give the impression that, in general, German surgeons prefer to wait in cases of acute disease of the gall-bladder. Lyons and Judd,<sup>3</sup> also in 1923, say that if the gall-bladder condition is acute, it is better to wait until the attack subsides before operating, and Judd and his associates renew the same statement in their article on the gall-bladder in Lewis's System of Surgery. Deaver,<sup>4</sup> in 1926, says that where possible, operation should be deferred until the acute attack subsides but that if conditions grow worse and interference is demanded, the acutely inflamed, gangrenous or perforated organ should be removed if possible. Graham,<sup>5</sup> in 1928, expresses the view that it is seldom advisable to operate upon a patient with acute cholecystitis. He thinks that there is greatly increased danger of infection when operation is performed on an acutely inflamed gall-bladder and that it is particularly dangerous to remove the gall-bladder in the acute stage of cholecystitis. He further states that perforation of the gall-bladder occurs so rarely that one is justified in waiting for acute symptoms to subside in practically every case. Bruggeman,<sup>6</sup> in 1928, quotes Haggard, Archibald, Dean Lewis, McGuire and Richardson as favoring delay in acute gall-bladder cases, giving references to their publications in his own article, and concludes by saying that there is ample support for his position in thinking operation is rarely indicated in acute cholecystitis. It will be seen from this brief summary of a few noteworthy publications that there is a heavy battery of opinion opposed to prompt operation in acute gall-bladder disease.

The following references to literature, however, disclose the fact that there is substantial support for the opposite view. Walton,<sup>1</sup> in 1923, compared acute cholecystitis to acute appendicitis and advises immediate operation in all cases. In 1924, Bland-Sutton<sup>7</sup> felt that all cases should be operated upon immediately and that it was reprehensible not to remove the acute gall-bladder. Kirschner,<sup>8</sup> in 1924, advocated early operation because he believed that the patient was more willing to be operated upon during the attack and that the operation itself was easier, but he usually took one day for pre-operative preparation unless the patient was very ill. Crile<sup>9</sup> found in going over his gall-bladder statistics that he was impressed by the large percentage of

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cures following cholecystectomy in acute cases Leriche and Cotte, quoted by Bruggeman,<sup>9</sup> insist that cholecystitis be treated by immediate cholecystectomy, and Bruggeman<sup>6</sup> also says that French surgeons generally advise immediate operation Miller<sup>10</sup> read a paper before this Society in 1930 reporting his personal experience and a series of unselected cases from the Massachusetts General Hospital As a result of his investigations he felt that the general principle of operating on septic processes without undue delay held true for the gall-bladder and that severe pain was the best indication for prompt operation Alexander<sup>11</sup> reported a number of cases which perforated while being watched and that out of twenty cases which had so perforated, there was a mortality of 50 per cent He also favors early operation because of the dangers of delay Mentzer,<sup>12, 13</sup> in two papers (one in 1930 and another in 1932), makes a strong plea for immediate surgical intervention In the last of these articles he presents an extensive statistical study, the striking features of which are as follows Eight cases of gall-bladder disease died while being treated medically Of the cases treated surgically, thirty-one had advanced to perforation or gangrene while they were being watched and the mortality in the delayed operation cases of the acute type was 33 per cent, as compared to 19 per cent in those operated on early in the disease He earnestly insists that advanced acute cases cannot be recognized in many instances, even by the ablest physicians, and that, therefore, operative intervention should be undertaken early in every doubtful case Nine out of twenty cases of ruptured gall-bladder had been kept in the hospital under observation for eleven days or more Zinninger,<sup>14</sup> in 1932, also presented an elaborate study of statistics bearing on the subject under discussion His findings indicate the great variation in the *pathological* changes discovered in patients presenting apparently the same condition *clinically* and serve to illustrate the difficulty in deciding which cases will subside under conservative treatment and which will become progressively worse In cases operated upon less than forty-eight hours after onset, there was no mortality In those operated upon in two to five days, there was a 66 per cent mortality and in those operated upon after five days, the mortality was 25 per cent—these cases, of course, all being acute cases After analyzing his experience from different points of view, he concludes that in acute infections of the gall-bladder, operation should be immediately performed if the symptoms are severe and that this is particularly true if there is a high leucocyte count To conclude this cursory survey of the literature, it may be pointed out that the volume of opinion in favor of prompt operation, as indicated by published articles, is growing steadily in the last few years and, finally, it may be interesting to know that at the Johns Hopkins Hospital Doctor Lewis,<sup>15</sup> Professor of Surgery, believes in the conservative handling of acute gall-bladder cases, whereas Doctor Finney<sup>16</sup> is a strong supporter of prompt operation

It will be seen from the quotations presented that although there is wide diversity in opinions and statistics of results, nevertheless there is plenty of statistical support for the belief that better average percentages of recovery may be expected with early rather than delayed operation We wish to approach the problem from a viewpoint other than the statistical, however If it be sound principle to remove the inflamed appendix early, before other structures become involved, and if it be wise to operate promptly on perforated peptic ulcers to decrease the spread of infection, it seems logical to treat the acute lesions of the gall-bladder in the same way It is true that there are certain differences, especially anatomical, in the usual relations of the appendix and of the gall-bladder The gall-bladder on one side is buttressed by the liver and on the other is closely adjacent to the duodenum and omentum When the gall-bladder becomes acutely inflamed, these two latter structures frequently become adherent to it and so tend to wall it off

from the general peritoneal cavity reducing the chances of widespread infection should a leak take place in the gall-bladder. It is also true however that the appendix is by no means always an organ lying free in the open peritoneum. It is often retrocecal, retro-ileal or lateral, so that it is wholly or partially sequestered from the general abdominal cavity, but no one on that account advises delay in removal of an acutely inflamed appendix. It is likewise true that a leak in the duodenum or stomach may permit much more extensive and gross soiling than a leak in a distended gall-bladder, but any one who has realized the quantity of infectious material that a distended gall-bladder may contain will not be inclined to underestimate the possibilities of contamination that its rupture may entail. It is also true that the gall-bladder is a much more capacious and elastic structure than the appendix and hence less prone to early rupture or perforation or gangrene, but, nevertheless, such complications do occur in acute lesions of the gall-bladder also. In short, the same reasoning from a knowledge of pathological processes that deduces the wisdom of early operation in acute appendicitis and perforated peptic ulcer should lead to a similar course of action in acute gall-bladder disease, the only difference being that certain anatomical differences make the necessity for speed less urgent in the case of the gall-bladder. These differences, however, are differences of degree and not of principle. They do not justify a change from the plan of prompt operation before disease processes extend to other structures to the plan of waiting for the subsidence of acute inflammation in order to perform an interval operation. In other words, one may say that acute appendicitis and acute perforated ulcers constitute emergency conditions of the first degree of urgency, whereas acute gall-bladder lesions are also emergency conditions but of the second degree of emergency. In support of this view, a few cases will be presented with brief comments.

CASE I—Mrs J B. One month following Cæsarean section this patient was seen as an emergency case with a mass in the upper right quadrant of the abdomen. There had been abdominal pain, tenderness, fever and chills over a period of eight or nine days during which time the obstetrician had searched most carefully for some cause connected with the Cæsarean operation as an explanation for the patient's illness. When seen by one of the writers it was obvious that there was a large abdominal abscess in the upper right quadrant which was opened under local anæsthesia and a large amount of pus with several facettted gall-stones was evacuated. Patient recovered from the operation with a persistent biliary sinus and nine months later had the gall-bladder and the persistent sinus removed at a second operation.

*Comment*—This case shows what may happen in deferred operations on the gall-bladder. It was also a case in which cholecystectomy seemed out of the question but it illustrates the possibility of a second operation being required where the gall-bladder cannot be removed at the first operation.

CASE II—J M T F. Typical history of gall-bladder disease with a diagnosis of gall-stones and acute cholecystitis. The plan of waiting for an interval operation was adopted and the patient improved considerably after the first week or ten days. This improvement was of short duration however, and a second flare-up took place which was again treated by the method of delay. Improvement did not occur, however, and after a total interval of twenty-three days, operation was performed by Dr W A Fisher and acute cholecystitis with rupture of the gall-bladder was found.

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*Comment*—This case illustrates that even though transitory improvement may occur, the course of the disease does not necessarily go on to quiescence but that a second intensification may be even more severe than the first. There is little doubt that prompt operation in this instance would have prevented a rupture of the gall-bladder. In this case the gall-bladder was removed at operation.

CASE III—W P Patient was admitted to the hospital with a diagnosis of acute gall-bladder disease and was kept on the medical service with the idea of operation after the acute symptoms had subsided. His condition, after fluctuating a little for two or three days, steadily grew worse and he was operated on six days after admission to the hospital for a gangrenous gall-bladder which had ruptured. The gall-bladder was removed at operation and the patient made a complete recovery.

*Comment*—Although the waiting period in the hospital in this instance was much less than is frequently seen in institutions where the delayed plan of operation is in practice, nevertheless it was sufficient to permit most extensive and dangerous changes to take place in the gall-bladder.

CASE IV—Mrs McD Patient was ill at home seven days with typical symptoms of acute gall-bladder disease and was brought to the hospital by her husband, who was a physician, because her symptoms were getting steadily and alarmingly worse. Operated on immediately. Acute cholecystitis with empyema of the gall-bladder was found. Because the patient's heart was regarded as in a doubtful condition from long-standing myocarditis, cholecystostomy alone was done. Patient recovered but had a persistent biliary fistula. Second operation four years later with removal of the gall-bladder.

*Comment*—This case illustrates that emergency operation in badly infected gall-bladders, with a generally unsatisfactory condition of the patient, is not necessarily a fatal or highly dangerous procedure and it again illustrates the desirability of removal of the gall-bladder when it is feasible to do so.

CASE V—Mrs E L Patient was seen at her home with her family physician and acute gall-bladder disease of three days' duration was diagnosed and immediate operation advised. Patient was very reluctant to submit to operation and refused to accept the advice. The condition, however, grew steadily worse and five days later operation was performed and an acute empyema of the gall-bladder was drained. This patient recovered completely after a longer convalescence than would have been required had the gall-bladder been removed.

*Comment*—In this case it was the patient's decision to defer operation that led to the delay, but instead of improvement taking place, the condition grew steadily worse and overcame, by its intensity, her reluctance to be operated on.

CASE VI—A K Patient was admitted to the hospital with a clinical picture which was not entirely clear. Acute disease of the gall-bladder was considered the most probable diagnosis, but because of the uncertainty, it was decided to watch him for a time in the hopes of reaching more certain conclusions. Within two days his condition became speedily worse and it was then very evident that he did have acute gall-bladder disease. He was operated on promptly and a gangrenous gall-bladder, packed with numerous small stones, was removed. This patient made a complete recovery.

*Comment*—In this instance the delay of two days was occasioned by uncertainty in the diagnosis. It serves to illustrate what rapid changes may take place in a gall-bladder that was not sufficiently typical to lead to an exact diagnosis.

CASE VII—Mrs H B McN Patient had been ill at home for four days and was brought to the hospital with the signs of acute gall-bladder disease in intense form. She was operated on immediately. Acute cholecystitis was found and the gall-bladder removed. Complete recovery.

CASE VIII—Mrs W D Patient had been ill three days at home with typical symptoms of acute gall-bladder disease. She was brought to the hospital and operated upon immediately as an emergency. There was found an acute cholecystitis with perforation and small leak. Gall-bladder was removed and patient made a complete recovery.

CASE IX—W T Patient was admitted to the hospital after nine hours of illness so intense, and with such a rigid upper abdomen, that a diagnosis of probable perforated ulcer was made. Immediate operation performed and an acute cholecystitis was found, with a stone impacted in the cystic duct. Gall-bladder was removed and the patient made an uneventful recovery.

*Comment*—The last three cases are considered as illustrations of acute gall-bladder disease treated by immediate operation with removal of the gall-bladder and entirely satisfactory results. There have been many other such cases but these serve as ample illustrations.

Upon the basis of these cases we wish to make a comment on the sequence of pathological events. When the cystic duct is completely blocked and increasing tension develops within the gall-bladder, there can be no reasonable hope of a spontaneous recession of the process. The logical outcome is rupture with either a localized abscess or a general peritonitis—in other words, an extension of disease beyond the organ of its origin. Further, when pressure of a stone in the cystic duct, or of swelling and oedema from inflammation, or torsion of a gall-bladder with a mesentery leads to occlusion of the cystic artery, gangrene and not improvement will be the consequence of delay. There may be some more gifted diagnosticians than we who can foretell which cases will subside and which will become critically dangerous after several days. Such men can infallibly choose the cases that must be done early and let the others “cool off.” Not only are we unable to make this distinction but we have no regrets about it. We think that those cases that are going to become worse clearly need early operation and we further think that those that might subside do just as well if operated on promptly. We think that by prompt operation there is a notable saving of time, pain, expense and danger as compared with the policy of delay.

From our experience we wish to draw another inference. Not only do we regard the acute gall-bladder lesion whether hydrops, empyema, torsion, gangrene or simple acute cholecystitis, as best treated by prompt operation, but again contrary to general opinion we believe that in most cases the operation should be a cholecystectomy. There may, of course, be instances where the patient's general condition requires the simplest and quickest surgical procedure—cholecystostomy—but in the large majority of cases the removal of the gall-bladder will not be too great a hazard. Furthermore, the worse the condition of the gall-bladder—badly infected or gangrenous—the more reason to attempt its removal if conditions permit. We have been gradually reaching this position during the past five or six years, and have been better satisfied with the results. During this time cholecystectomy has been carried out on a number of cases of all forms of acute gall-bladder disease without the loss of any of them. The series is too small to have any statistical value, hence we offer our views not as matters of proof but only as opinions with some backing of experience. Certainly there are obvious advantages in cholecystectomy. There is a prompt removal of a damaged, useless and infected structure. There is the avoidance of the not infrequent necessity of a secondary operation. Finally, there is a shorter, smoother, convalescence with all that goes with it—fewer dressings, less pain, less expense. In

regard to the matter of the type of operation, we are also convinced that if early attack is adopted as a principle, and delay in the hope of subsidence is abandoned, there will be fewer cases encountered at operation in which the surgeon will hesitate as to the removal of the gall-bladder. Not only will the local lesion be less formidable, but the patient will be less apt to have reached a critical general condition.

The arguments that seek to prove the advantages of interval operations are to us unconvincing. The most plausible of these arguments is that operation on gall-bladders in the stage of acute disease requires greater skill and judgment than operation on a quiescent gall-bladder and that many surgeons are not competent to meet these additional requirements. We would reply that standards of surgical treatment should be based on the course which offers the best results in competent hands. It is not sound policy to compromise principles of treatment to suit an assumed deficiency of skill in the profession. If a given plan of handling a surgical situation is conceived to be the best, it should be adhered to as the ideal. It then becomes a matter of each individual surgeon's conscience as to whether he or some other man is most capable of carrying the idea into practice. The objection, voiced by many, that early operation is more dangerous because of the chance of spreading infection, seems not to be borne out by our experience. Furthermore, as Miller<sup>10</sup> says, the general principle of prompt intervention in septic processes in the abdomen should apply as well to the gall-bladder.

To summarize, we are convinced that prompt surgical attack is the method of choice in all types of acute gall-bladder disease. This opinion is supported by the facts of pathology, by analogy with other acute abdominal conditions, and by actual experience as demonstrated in personal cases and by selected statistics. We further believe that in acute cases, cholecystectomy is the operation of choice and that only very special conditions should lead to its rejection.

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## TREATMENT OF ACUTE CHOLECYSTITIS

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THE management of acute cholecystitis arouses more differences of opinion among surgeons than that of any other acute abdominal disease of like importance. In 1928, Bruggeman<sup>1</sup> presented a paper in which he made a careful review of surgical practice in the treatment of acute cholecystitis both from the literature and from personal communication. He found opinion divided in England, in favor of intervention without delay in France and in general conservative in Germany, although Kirschner<sup>2</sup> favors early intervention in acute cases after a day or two of observation. In this country the majority prefer to wait for the attack to subside unless the condition is urgent. Bruggeman himself felt that operation is very rarely indicated in the acute stage.

Most of the more recent American contributions have pointed out the dangers of delay and advocated prompt surgery in doubtful cases. Three years ago, Miller,<sup>3</sup> in a paper before this Association, advised early intervention if "there is a persistence of temperature, tenderness and spasm, and particularly, and most important, if there is severe pain, not easily controlled." H. F. Graham<sup>4</sup> reported a series of acute cases in which he found those operated on within forty-eight hours did better than those in whom there was a longer delay. In about 63 per cent of Zininger's<sup>5</sup> series the attack either failed to subside or became worse. He advocated early operation, but not immediate intervention as a routine. Mentzer<sup>6</sup> made the point that advanced acute cholecystitis cannot be recognized in many instances and therefore that operation should be undertaken earlier in case of doubt.

Mortality percentages after operation in acute cholecystitis as given by recent writers are Miller,<sup>3</sup> 13.5 per cent, Whipple,<sup>7</sup> 13.7 per cent, H. F. Graham,<sup>4</sup> 6 per cent, and Zininger,<sup>5</sup> 7.8 per cent.

I have been impressed with the favorable post-operative course of patients subjected to early cholecystectomy and have operated before the fever subsided in a majority of my own cases without feeling that an error of judgment had been made until rather recently, when an obese woman of fifty-two, who had had several attacks, succumbed two days following a partial cholecystectomy, with rapidly rising temperature and failing circulation. In order to throw light on the problem the biliary surgery on the ward patients for the past twelve years at St. Luke's Hospital, New York City, has been reviewed. As the point is to examine the treatment in acute inflammation of the gall-bladder and compare it with that in chronic inflammation and stone cases of malignancy, stricture and multiple operations have been omitted from the tabulation, appendectomies excepted.

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In this series there were 1,053 cases operated upon by twenty surgeons with a mortality of 6.7 per cent. For the purposes of this study the series is divided into

Acute,	107 cases with 10 deaths,	9.3 per cent mortality
Subsided,	94 cases with 5 deaths,	5.3 per cent mortality
Chronic,	754 cases with 24 deaths,	3.3 per cent mortality
Duct stone,	98 cases with 32 deaths,	33 per cent mortality

The duct-stone cases, whether acute or chronic, were separated because they represent a different as well as a more serious situation. The so-called chronic cases form a group which serve as a basis for comparison. Tabulation of a considerable proportion of this group shows that approximately 80 per cent had stones and that 97 per cent were subjected to cholecystectomy.

It is the remaining two groups, totaling 201 cases, which form the basis of this study. In order to make a comparison between active and subsided cases, a temperature of 100° F. was arbitrarily chosen as a dividing line. Those classified as acute were operated on with very few exceptions during the febrile stage according to this criterion. Of those rated as subsided about one-half entered hospital with fever, the remainder with the history and signs of an acute attack. They averaged three to four hospital days without fever before operation.

*Pathological Findings in Acute Cases* —Of this group five patients, exclusive of those who formed abscesses, were found to have either perforation of the gall-bladder or bile in the peritoneal cavity without perforation being recognized. They were all urgent cases requiring prompt surgery. All occurred in the first three days of illness. Eleven patients had empyema of the gall-bladder, eight gangrenous cholecystitis on pathological examination and eleven an abscess outside the gall-bladder wall. Allowing for those in whom more than one of these conditions were reported there is a total of thirty-three patients, a little less than one-third of the group, who developed these more serious pathological findings. There were five deaths, one-half the fatalities, among them.

*Operation* —Cholecystectomy was carried out in eighty-five patients and drainage in twenty-two. The latter comprised the more serious cases and the mortality consequently is considerably higher.

Removal of an acutely inflamed gall-bladder demands more experience and skill than cholecystectomy for chronic cholecystitis. Bleeding is likely to be troublesome. The distended and more or less rigid organ makes exposure difficult. Sometimes it is expedient to amputate through the neck rather than dissect out the cystic duct. On the other hand, in the earlier stages the oedematous organ, particularly if it is not already fibrous from repeated attacks, may be shelled out relatively easily. By the time the patient has cooled off, organization in the still red and thickened viscus may have progressed sufficiently to render dissection considerably more difficult.

*Mortality*—A convincing reason for conservatism in acute cholecystitis is the experience of a fatality after early operation in a case which might have recovered if there had been less haste. In looking over the operative deaths in this series it is possible to pick out two or three in which the intervention or the type of operation done seemed ill-judged. On the other hand, reckoning from the onset of illness those operated upon within the first week showed a mortality of 7.8 per cent as contrasted with 15 per cent for the remainder. Zinninger's<sup>5</sup> figures also showed a lower death rate in the first week. Miller<sup>3</sup> found that the fatal cases averaged fifteen days from the onset of illness to operation while those who recovered averaged eight (Table I).

TABLE I  
*Causes of Death in Acute Cases*

Shock	2
Pulmonary embolism and thrombosis	2
Bronchopneumonia and cardiac failure	1
Myocarditis and bronchitis	1
Calculus pyonephrosis	1
Liver shock? (High temperature, early death)	1
Asthenia and progressive weakness	1
Septicæmia	1

In considering the mortality I am impressed by the fact that fatalities were confined to older patients, the youngest being forty-seven, the average age fifty-nine. Peritonitis did not seem to be a contributing cause of death as frequently as one might expect. It is strongly suspected in two of the cases, one of whom died with a bacteræmia. Pneumonia likewise was not conspicuous. It was diagnosed as present at the time of operation in one patient drained under local anæsthesia. Six of the ten fatal cases had had previous attacks, a number of them shortly preceding the final illness.

The average post-operative hospital stay of the acute cases was twenty-one days, as opposed to nineteen in both the subsided and chronic groups.

*Follow-up*—Of the seventy-nine patients leaving the hospital on whom cholecystectomy was done, there are follow-up examinations on seventy-one varying in time from two months to several years. In 83 per cent the results were good or fair. Thirteen per cent, or nine individuals, had colic-like attacks at some time. These were usually not persistent but two came to a second operation in which stones were found in a remnant of the gall-bladder. Four per cent developed incisional hernia.

Sixteen of the eighteen leaving hospital after drainage operations were followed up. Seven had a good result. One died two years later of cholæmia. Eight came to secondary cholecystectomy with two deaths.

*Subsided Group*—In this group it is interesting to note that seven had empyema of the gall-bladder, four gangrenous cholecystitis according to the pathological report, three were described as having a perforation of the gall-bladder without abscess being mentioned and four an abscess alongside the

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gall-bladder One or more of these conditions were found in sixteen of ninety-four patients, a surprising proportion of serious pathological findings in those who had become or remained afebrile Cholecystectomy was done in all but three patients approximately the same proportion as in the chronic group Occasionally, however, a portion of the neck was left The five deaths were with one exception in individuals over fifty, the average age being fifty-seven (Table II)

TABLE II  
*Causes of Death in Subsided Cases*

Cardiac failure	2
Cerebral hæmorrhage	1
Pulmonary thrombosis	1
Liver shock? (High temperature, early death)	1

There are follow-up records on sixty-eight of these patients subjected to cholecystectomy Ninety per cent had a good or fair result Three had attacks of pain of whom two came to secondary operation One of these had adhesions only the other a stone in the common duct This latter patient died Three developed incisional hernia One died at home two months after operation of unknown cause Of the three who were drained one had a good result, one died after secondary cholecystectomy while the third is a recent case

*Discussion*—Those who advocate a waiting policy in acute cholecystitis point to the considerably higher mortality in operations done during the acute phase and the tendency of the attacks to subside without that danger of infecting the peritoneal cavity which is the rationale for emergency surgery in appendicitis The mortality figures cannot be accepted at their face value for comparison because they include the fulminating cases and those who fail to resolve Were it possible to select from the acute cases only those which might be considered operations of election, then a fairer basis of comparison would exist This I have tried to do in the series reviewed but have found it unsatisfactory because the degree of urgency is not clear in so many of the records

I am satisfied that immediate operations on patients with acute gall-bladder disease are unwise unless the evidence points to a free perforation A period of observation not only allows for a more accurate grasp of the condition of the patient but for preliminary treatment

The pathological findings already mentioned indicate how frequently an acute attack may go on to a serious condition This, together with the high mortality in those cases which have failed to subside and come late to operation serves to emphasize that the surgeon should be ready to intervene promptly if the progress of the case is not toward improvement

Should one wait whenever possible for an acute case to subside? A number of the surgeons who have contributed to the series have not hesitated to operate early There are many of these cases whose post-operative

course has been uneventful and short and who have been spared extra days of illness and expense as well as the possible development of a more serious condition. The fatality mentioned at the beginning of this paper serves, however, to emphasize the necessity of careful selection. A routine of indiscriminate early operation would, I suspect, increase the mortality. On the other hand, in younger patients, in good general condition, who have been under observation and preparation for a day or two, one may, it seems to me, intervene without waiting for the afebrile stage.

The general policy of those who treat the acute attack expectantly is to operate after some days of normal temperature. If the mortality figures are to serve as a criterion the question naturally arises as to whether the plan should not be carried to its logical conclusion and the patient sent away for complete resolution before removing the gall-bladder. It may be said against this suggestion that an appreciable percentage of the apparently subsided cases have pathological conditions, at times unsuspected, such as abscess, in which a relapse will occur. Several of the fatal cases in the acute group had had recent attacks. Of those cases coming to later cholecystectomy after drainage in this series the mortality has been high. After a serious acute attack one cannot expect as low a death rate as in the general run of cholecystectomies. In spite of these objections a longer interval before operation would seem to offer advantages in certain cases.

*Conclusion*—Patients with acute cholecystitis should not be operated on immediately upon admission without an urgent indication. The surgeon should be ready to intervene promptly if progress is unfavorable. Younger patients in good condition after a day or two of preparation may be operated upon without waiting for the attack to subside. In poorer risks, if the course under observation is satisfactory it is wiser to allow the acute attack to cool off.

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# ACUTE CHOLECYSTIC DISEASE

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IN ACUTE and subacute cholecystitis, one of the outstanding features from a microscopical standpoint is the presence of œdema of the wall of the gall-bladder. The interstices of the tissue are filled with fluid. In acute cholecystitis the walls are also infiltrated with leucocytes. In subacute cholecystitis, there is a relative decrease of the proportion of polymorphonuclear neutrophils and replacement of them by lymphocytes and plasma-cells.

Often a condition is found which is designated as acute or subacute cholecystitis on a chronic cholecystitis. Such a diagnosis is made when, in addition to the other features, it is possible to demonstrate an excess of fibrous tissue in the walls of the gall-bladder. From a macroscopical standpoint, this excess fibrous tissue is usually denoted by unusual trabeculation.

Gangrenous cholecystitis occurs more often than was formerly thought. Gangrene may be mistaken for phlegmonous cholecystitis. In a few cases we have observed the gall-bladder completely separated from the surrounding attachments, so that it could be removed without dissection.

*Etiology*—Continued studies seem to support the idea that cholecystitis is not always the result of infection. In some instances, using every known means, and following the most careful technic, it is not possible to find causative bacteria. It might be assumed that bacteria had been present in the tissues at some time, or that they had been present at the time of examination but had not been found. However, there is evidence that the changes observed are not always the result of bacterial invasion for similar lesions of the gall-bladder have been produced by introducing certain chemicals into the blood-stream of experimental animals. Furthermore, what part disturbances of metabolism play in the etiology of cholecystitis is not known. The significance of deposits of lipoid in the wall of the gall-bladder is not well understood. Possibly the deposits are the result of a simple physiological process, but their presence in cases in which there is clinical evidence of cholecyctic disease makes one wonder what part they really play.

*Precedent and Opinion*—Experience has added much to knowledge but apparently there is still a great deal to be learned before there will be an invariable set of clinical criteria that will establish the diagnosis and determine the immediate course to be pursued. Men of wide experience hold

opposing views a well-known surgeon has stated that cholecystectomy during the acute stage of the disease entails unwarranted danger, but a surgeon of international repute has recommended immediate operation, with cholecystectomy as the objective

Love, in the Hunterian Lecture given in 1929, said that until recently the trend had been to allow the acute inflammation to subside and then to perform cholecystectomy after remission of symptoms. He reported that Hotz, in 1923, produced figures indicating that the mortality from operation during the acute attack is double that following surgical treatment after subsidence of symptoms. Pauchet, in 1926, subscribed to the opinion of the French schools, that if operation is indicated during an acute attack, drainage of the gall-bladder is preferable. The opinion expressed by Love was that there are two main objections to delayed treatment. First, the patient may, to his detriment, refuse subsequent operation. In Love's series of sixty-nine cases in which the acute condition was given time to subside, there were seventeen in which operation was not performed subsequently. The second objection is that there is a greater possibility of erroneous diagnosis, since perforated ulcer, acute intestinal obstruction, pancreatitis, and inflammation of a high-lying appendix may all be mistaken for acute cholecystitis. Love found that the mortality in all cases in which expectant treatment was given was 13 per cent, and that intervention was necessary in nine cases of fifty-two in which treatment was along expectant lines. In two cases general peritonitis occurred following gangrene of the gall-bladder. Love concluded that operation during an acute attack of cholecystitis carries a high mortality rate, in his series of cases it was 21 per cent. Furthermore, he stated that in most cases in which expectant treatment is given the condition will subside.

In Zinninger's study of eighty-nine cases of acute disease of the gall-bladder, thirty-five patients were operated on immediately after admission, and fifty-four were observed for from one to twelve days before operation. Of those who were kept under observation, the condition of only 37.7 per cent was improved, and the gall-bladders of these were found subacutely or chronically inflamed at operation. No significant change in signs or symptoms was observed in 35.1 per cent of the cases during the period of observation, uncomplicated acute cholecystitis and empyæma were the lesions most frequently found at operation. In a third group, composed of 27.7 per cent of the entire series, the patients grew definitely worse during observation, and empyæma, gangrene, or rupture of the gall-bladder was found. The total number of cases in which symptoms and signs failed to subside was thirty-four (62.9 per cent). Zinninger made considerable of the fact that the average total number of leucocytes in these cases was more than 15,000 in each cubic millimetre of blood. He wrote that in all cases of empyæma it was more than 15,000. He also expressed the belief that the incidence of serious pathological lesions and the mortality rate rose with the duration of the attack and that, with early operation, the stay of the patients in hospital and the mortality rate were less. Zinninger recommended that in the presence of acute infections of the gall-bladder, immediate operation be performed if the symptoms are severe, and particularly if there is an associated high leucocyte count. He gave the opinion that early operation is indicated if the attack fails to subside promptly. In the cases which he studied, operation was performed between 1925 and 1930, and, I believe, by a number of different surgeons.

Graham reported on early operations for acute cholecystitis, and concluded that early operations give better results. He wrote that in a series of cases in which operation was delayed, many of the deaths could be attributed to the delay, longer and more difficult operations were necessary, and the number of post-operative complications and of days in hospital were increased.

Miller reported that if there is persistence of increased temperature, tenderness, and

spasm and most important if there is severe pain that is not easily controlled, surgical intervention should be undertaken without delay. He selected 200 cases in which operation was performed for acute cholecystitis. In the fatal cases, the average duration of symptoms from onset to operation was fifteen days, and in the cases in which the patients recovered, 82 days. He said that the reason for the long time between the onset of symptoms and operation was that the patients were sick at home before they came to the hospital. In any event, there is a striking difference between the two groups. In the fatal cases, palliative treatment had been given for an average of a week longer than in the cases in which the patients recovered.

*Symptoms May Be Masked or Inadequate*—That it is not always possible to estimate the condition until the abdomen is opened is illustrated by the following experiences. In a recent article, Mentzer stated that in four instances perforation of the gall-bladder occurred while the patients were under observation and the condition was not recognized before death in any of the cases. In the course of a number of years we have encountered seven cases of acute cholecystitis in which general abdominal infection developed while the patients were under observation. In none of these cases were we able to recognize symptoms that would suggest disease of the gall-bladder, and it was not suspected that rupture of the viscus was the cause of the trouble until this was revealed at necropsy. In view of the results of our present study, we believe that in all cases in which there is acute abdominal distention and paresis from peritonitis, and in which there is no evidence of the source of the disturbance, the gall-bladder should be suspected of being the site of origin.

In addition to these seven unrecognized cases, we have found acute cholecystic disease present eighteen times at necropsy although the condition of the gall-bladder was not responsible for the death. In all of these the symptoms usually referable to disease of this viscus were either overshadowed or were not present.

*Results in 508 Cases of Acute Cholecystitis*—In these 508 consecutive cases of acute cholecystitis in which we shall report the results of operation, 196 of the patients were males and 312 females. Of these patients, 248 had their first acute symptoms during the attack in which they consulted us, and in thirty-eight of these cases the attack marked the onset of symptoms. Two hundred and twenty-two patients had experienced previous spells of acute abdominal pain and digestive disturbance. Colicky pain and tenderness in the upper part of the abdomen were the outstanding complaints. Of the 508 patients, 332 had had pain of a colicky nature. In every instance the abdomen was tender. The records also revealed that in ninety-eight instances there was a palpable mass in the upper part of the abdomen.

The body temperature was elevated at the time of the examination in only 106 of our cases. In fifty-three leucocytes numbered more than 15 000 in each cubic millimetre of blood. It was interesting to find that in 354 of the 508 cases leucocytes numbered between 5,000 and 10 000, in four less than 5,000. In other words, in the majority of instances, the leucocyte count was within normal limits and entirely out of proportion to the severity and extent



of the existing infection in the biliary tract. This may tend to support the idea that infection is not responsible for the condition of the gall-bladder in many of these cases.

Stones were present in the gall-bladder in 484 cases. Forty-three of the patients also had calculi in the common bile-duct.

The pathological changes in acute appendicitis have been compared with those of acute cholecystitis, and it has been found that generalized infection of the peritoneum is a much less common complication with inflammation of the gall-bladder. When the gall-bladder becomes inflamed, it is rapidly shut off by adhesions, so that perforation of the viscus into the general peritoneal cavity is an uncommon event. Turgidity may be confused with distention. The walls of œdematous gall-bladders which are the site of acute disease are often one-half inch (1.27 centimetres) or more thick. It is easy to imagine at operation that the gall-bladder is on the point of bursting, and that the operative procedure has fortunately just averted this calamity. Perforation is probably due, in all cases, to local gangrene of the wall of the viscus, although popular opinion pictures the gall-bladder as bursting like an over-blown balloon. In sixty-eight cases of our series, the wall of the gall-bladder was gangrenous. It had perforated in sixty-one cases, with formation of an abscess about the viscus in thirty-eight. In three cases it ruptured into the general peritoneal cavity and general peritonitis ensued. The disease of the gall-bladder was responsible for the formation of a cholecystoduodenal fistula in six cases, in one case there was a cholecystocolonic fistula. That the infection was not only acute, but also was extensive, is shown by the fact that definite involvement of the pancreas was recorded in eighty-one of the 508 cases, and this figure probably does not adequately express the frequency of such a situation.

Cholecystectomy or the removal of all of the gall-bladder except the portion embedded in the liver was performed on 419 of our patients. Eighty-nine underwent cholecystostomy. It was found necessary to open the common bile-duct and to establish drainage of the biliary tract in seventy-two of the cases, in addition to the procedure referable to the gall-bladder itself. There were nineteen deaths following cholecystectomy and five following cholecystostomy.

*The Time for Operation in Cases of Acute Cholecystitis*—A review of the literature shows that there is considerable difference of opinion regarding the time for surgical treatment in cases of acute cholecyctic disease, and regarding the question of whether it is ever permissible to consider an emergency procedure. In fourteen of our cases, the operation was performed as an emergency measure. One of the patients died. In this instance, cholecystectomy was performed for acute gangrenous cholecystitis with stones. Death resulted from general peritonitis and terminal bronchopneumonia.

We shall probably not be able to settle the question of when to operate in the acute cases, but the present tendency is to carry out surgical treatment

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early in cases of acute cholecystic disease. Apparently there is not the same fear of operating in these cases as there formerly was. We are inclined to think that this is due to recognition of the fact that infection is not always the cause of the condition and that these patients can have the necessary surgical treatment with comparative safety. In these acute cases, the operation usually should be removal of the gall-bladder. Our study of this group of 508 surgical patients would seem to bear out these conclusions although the operations were performed by several surgeons, among whom there were bound to be differences of opinion.

Although we wish to subscribe to the plan of early operation in acute cholecystic disease, and although this coincides with the opinion expressed in the more recent literature on the subject, nevertheless we feel that there are certain instances in which surgical treatment should be postponed. In some cases it should be delayed for a long time. In caring for these patients it will be necessary to consider each one as presenting an individual problem. There is no set plan that will fit all cases. The following illustrates the type of case in which we believe operation should be postponed.

A man, aged fifty-six years, registered at the clinic October 26, 1932. He had had attacks of severe epigastric pain over a period of seven months, but the last attack had occurred seven months previous to the time when he came for consultation. Vomiting had accompanied the attack.

On examination, his temperature, pulse rate and leucocyte count were normal. While roentgenological examinations of his biliary tract were being carried out he had a more severe reaction than usual. There was epigastric tenderness and rigidity. At the first examination after the roentgenological investigations, leucocytes numbered 10,300 in each cubic millimetre of blood, the temperature was 98.2° F, and the pulse rate seventy beats each minute. The next day the patient was definitely having one of his attacks and for a month afterward his temperature ranged from 100° to 105° F. The number of leucocytes varied from 15,000 to 22,000 in each cubic millimetre of blood. There was marked tenderness in the left upper abdominal quadrant, distention, and a palpable epigastric mass. At the height of the attack, the value for bilirubin was 2.1 milligrams in each 100 cubic centimetres of serum. After this pneumonia developed and the patient seemed altogether too sick to be operated on. Finally infection from gas bacilli developed in the left buttock. After the man had passed through all of this difficulty, and had been in the hospital for six weeks, it was decided that the best plan would be to proceed with the operation.

At the time of the operation, both subphrenic spaces were examined for fear that infection might be present there, but these spaces were normal. So far as could be determined there was no abscess anywhere. There were many adhesions around the gall-bladder, but no sign of general peritonitis. The gall-bladder was opened, and stones and pus were removed. Three days after operation the patient's temperature was normal and remained normal. The man has made a very satisfactory recovery.

Whether the attack was precipitated by the roentgenological examinations is difficult to determine. It is known that in some cases of disease of the gall-bladder an attack is precipitated in this way, but we never have seen one as severe as this. We are inclined to think that if operation had been performed early the patient would not have survived the operation.

*The Type of Operation*—Cholecystectomy will not be permissible in

every case, but this procedure should be carried out whenever feasible. This conclusion has been reached after watching the patients during their immediate convalescence and evaluating the ultimate results. It has been our experience that leaving the acutely inflamed gall-bladder *in situ* may result in continued drainage, pancreatic fistula, and then, after a number of weeks, death of the patient probably due to continued absorption. The thick-walled gall-bladder in an acute state can be removed as readily as one that has reached the chronic stage, and it seems that there is a definite advantage in removing this infected tissue.

No one would feel that a deeply situated, inaccessible, acutely inflamed gall-bladder should be removed from an extremely sick person. Cholecystostomy may be all that is warranted. However, some of these patients will have fistulæ which will persist until cholecystectomy is performed. In other instances, the gall-bladder undoubtedly shrivels and is eventually almost entirely destroyed by the inflammatory process. If cholecystectomy is finally performed in this type of case, every effort should be made not to traumatize the surface of the liver. To avoid this, a sufficient amount of the fibrous wall of the gall-bladder should be left on the surface of the liver to prevent extension of the disease into the hepatic substance.

Ordinarily the common bile-duct should not be opened during operation for acute infection in the gall-bladder. Usually it is inaccessible. There may be a great deal of œdema of the adjacent structures, making it difficult to recognize the duct. In most instances the disturbance is confined to the gall-bladder, and the condition is not complicated by the presence of stones in the common bile-duct. If the clinical history suggests the presence of a stone in the duct, or if a calculus can be felt in it, then an attempt should be made to clear that situation.

*Summary and Conclusions*—In many cases infection is undoubtedly the principal factor in the changes observed in the gall-bladder and biliary tract. In other instances in which there is no detectable infection, however, the reaction in the tissues seems identical. Experimental studies seem to indicate that this may be the result of some alteration in the chemical reactions of the body. With changes in metabolism, lipoids may be deposited in the wall of the gall-bladder. Future investigations may prove that this phenomenon plays an important part in the disturbances occurring in the biliary tract.

Cholecystectomy is preferable to cholecystostomy in all cases in which the condition of the patient will permit carrying out the operation without unwarranted risk. In a small proportion of the cases cholecystostomy will be indicated.

The results obtained in our series of cases seem to justify the plan of operating early in cases of acute cholecystic disease.

DISCUSSION—DR FRED B. LUND (Boston, Mass.) said some years ago surgeons always waited for gall-bladders to quiet down thinking that they got the best results in

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that way. In recent years he had come to Doctor Stone's conclusion, that is, the gall-bladder is as much an emergency as an appendix except that one does not have to operate on it in the middle of the night as in peritonitis from appendicitis. He had been called in the evening to see a fat woman with a very distended gall-bladder and acute symptoms, and arranged to operate in the morning. By morning the tumor had entirely disappeared, she had a general peritonitis and the gall-stones were spread around the peritoneal cavity. In some occasional cases it is not wise to wait even a short time. Operations in subacute cases where the gall-bladder is thick do just as well as in the chronic cases and occasionally cases that one thinks are subacute are really acute because the cystic duct is plugged and there is pus in the gall-bladder in spite of a normal temperature and very, very slight tenderness.

When he had waited for gall-bladders to quiet down, he had sometimes been disappointed, because they gradually got worse. While they were supposed to be quieting down fat necrosis was extending into the pancreas from the gall-bladder. So, everything considered, while not as urgent as appendicitis, the sooner an acute bladder is operated on the better. The more acute it is the more important it is to operate because those patients with very severe pain and high temperature are the ones in the greatest danger of perforating. They also welcome the operation at this time.

In cases where the cholecystectomy is technically too difficult one may have to do a cholecystostomy, but at any rate they have been saved from a very severe danger.

DR. RICHARD H. MILLER (Boston, Mass.) said that Doctor Stone, Doctor Smith and Doctor Judd each had mentioned a paper which he presented before this organization in 1929. What led Doctor Miller to do that was two very unusual instances of acute distention of the gall-bladder due to blocking of the outlet by stones. Each of those cases was one in which there was no infection. There was no previous inflammatory thickening, nor were there any adhesions. In one instance the gall-bladder swelled very rapidly, causing excruciating pain, followed by perforation. In this case the patient died. The second case, which was similar, underwent operation just as perforation was about to occur, and he recovered.

Doctor Miller was thereupon led to look up the cases of acute cholecystitis, so-called, at the Massachusetts General Hospital. He found the results were as Doctor Stone had already mentioned, namely that in those in which more procrastination had taken place there was higher mortality, whereas in those instances in which operation was performed early the mortality was less.

He felt now, after having observed similar instances for several more years, more or less as he said at that time, that one cannot lay down a hard-and-fast rule. Each case has to be judged on its own merits. If a patient comes in with an excruciatingly acute attack, the pain of which is controlled with difficulty, and a swollen gall-bladder, one can presume sudden distention, possible early perforation, and operation should be done immediately. If the patient shows more signs of sepsis and does not seem quite so sick, one is justified in waiting for twenty-four hours to bring the body fluids up to normal and do the operation under better conditions. In those people in whom the attack is not so severe, where perhaps it presents certain evidence of subsiding, then one can, without any particular danger, wait until the process has entirely subsided.

DR. JOHN HOMANS (Boston, Mass.) supported the contention that the gall-bladder of acute cholecystitis almost necessarily becomes in some degree necrotic by calling attention to what he first heard some years ago from a pathologist in New York who maintained that the disease was caused by the impaction of a stone in the ampulla of the gall-bladder in such a situation as to interfere with the blood supply of the whole organ. Pressure of the stone, by cutting off the venous return, first causes an acute passive congestion. That fits in with the violent œdema and with the dark redness of many of these gall-bladders. Possibly arterial ischæmia occurs later, but in any case necrosis of some part of the gall-bladder's wall is common.

Doctor Judd, in his first slide, showed a gall-bladder with a great indentation in the ampulla where the obstructing stone had been fitted. Such an appearance is typical. The vessels supplying the organ usually pass over the bulge made by the stone and are compressed at that point. Obstruction of the cystic duct itself probably acts in a different manner and does not necessarily lead to acute cholecystitis.

As for the part played by infection, though that is doubtless considerable, it must be admitted that if gangrene were due primarily to bacterial rather than to circulatory causes, acute cholecystitis would be an even more dangerous disease than it is, and operation would spread, rather than restrain, infection. Whereas, actually, as Doctor Stone and others have pointed out, early operation, at what might seem to be a most violent stage of infection, is followed by rapid healing.

DR HUBERT A. ROYSTER (Raleigh, N. C.) said that twenty years ago, in one year he saw two patients die of ruptured gall-bladder, one in the convalescence of typhoid fever and the other one without any previous history. Ten years ago he wrote some notes down with the following heading, "Shall We Operate Upon the Acutely Inflamed Gall-Bladder?" but he never had nerve enough to bring it out until three years ago when he heard Dr. R. H. Miller speak before the Association.

While he did not believe that the analogy between the gall-bladder and the appendix is a complete one, there is enough kinship to make one feel that, as expressed by others here, we are not to jump on the patient in the middle of the night. As a matter of fact, we seldom do that with appendicitis now. But, they lead us to understand that the acutely inflamed gall-bladder represents a partial analogy and sometimes a very definite one.

The feature which concerned him also was the very simple and easy methods by which the gall-bladder can be removed in the so-called subacute stage, that is, within a day or two of the beginning of the attack, after there has been a beginning or complete subsidence of the symptoms.

When a gall-bladder is attacked at that period, it can be peeled out very much as if you were peeling a banana and the access to the ducts is perfectly easy unless there have been many previous attacks. Therefore, we are not waiting in such a case for the firm, dense, hard adhesions which we allow to come in such cases as this.

The only thing to think back upon is this, in the old days the surgeon attacked acute appendicitis after he had waited for the abscess to form. Is it any more reasonable to wait in the case of the acute gall-bladder until jaundice has appeared?

DR. HARVEY B. STONE (Baltimore, Md.) said that he had expected to hear a great deal of adverse comment and thought he would have to defend his position, perhaps at a disadvantage. As far as he recalled none of the gentlemen who had spoken had taken any essential issue with the stand which he made.

He said there were, however, one or two things that were brought out in the papers of Doctor Smith and Doctor Judd, and certain things in his own paper which he did not have the time to bring forth, that he should like to emphasize.

One of them was the fact that many of the cases in which waiting fails to give good results are the most difficult of all. Doctor Smith pointed out in his paper that the cases in which subsidence fails to take place are the most difficult operations. They believe that if such cases were operated upon early the performance of the operation would be very much easier.

Another thing that he would like to say is that in reading over the literature in the days when nearly every voice was against early operation, there was a widespread emphasis upon the danger of spreading infection by operation upon the acute gall-bladder. Doctor Judd has shown infection perhaps is a secondary factor in the pathological condition that exists in most instances. As other speakers to the subject have pointed out, and as they mention in their papers, in most instances the acute and rapid change in

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the tissues is due to obstructive rather than to infectious factors, either the impaction of a stone in the duct with the accumulation of secretion behind, or pressure upon the cystic vessels and interference with the blood supply

In other words, there is here an analogy between the gall-bladder and the appendix, as brought out by Wilkie, who has emphasized over and over again that the dangerous cases of appendicitis are the obstructive rather than the infectious cases. As to their position in this matter, in agreement with everybody else, they realize that there are cases in which it would be folly to operate immediately, but they do feel that as a principle, as a general plan of attack, it is very much wiser from every standpoint to regard the acute gall-bladder as a condition to be relieved promptly rather than as a condition to be waited upon for a period of subsidence or cooling off

DR JOHN M T FINNEY (Baltimore, Md) recalled the development of biliary surgery. It was with great trepidation that the abdomen was opened and the gall-bladder exposed and stitched to the parietal peritoneum. Then, after waiting for a few days, a small opening was made in the gall-bladder and it was let drain, without attempting to remove the gall-stones. Then some bold soul began removing the gall-stones, and so cholecystostomy was established. Now we have reached another stage in the development of biliary surgery.

The question now is, shall we treat these cases as emergencies, like appendicitis, and take the gall-bladder out as soon as the diagnosis is made, or even when it is only suspected, as is done in the case of appendicitis, or are we going to run the risk of a perforation of the gall-bladder just as with the appendix? While the two conditions are not strictly analogous, there is great similarity between them.

Personally, due to a gradual process of evolution, he now takes a stand firmly in favor of treating the gall-bladder just as he does the appendix, that is, taking it out as soon as he is reasonably sure that it has any serious trouble with it.

This may seem to some a rather advanced position, but it seems perfectly logical when one listens to such arguments as have been presented this afternoon. While there is something to be said on both sides of the question, the weight of the argument is in favor of the more radical procedure. However, one cannot be absolutely dogmatic in any surgical question—or hardly any—and this is no exception. One should always exercise surgical judgment and be guided by it.

# ACUTE UROLOGICAL EMERGENCIES, PAST AND PRESENT

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DURING the last twenty-five years, owing to the rapid development of cystoscopical diagnosis and therapy, together with the perfection of radiography, many so-called emergencies of the past have been converted from operative surgical emergencies into much less urgent conditions. In the urinary tract, urological emergencies, outside of those caused by trauma, are due to (1) obstruction, (2) infection, and (3) spontaneous hæmorrhage.

*Obstruction in the upper urinary tract* due to intrinsic conditions, such as stone, tumor or stricture in the ureter, in the absence of infection rarely calls for an urgent operation, as most of these obstructive conditions can be relieved by the passage of a ureteral catheter, which takes care of the immediate emergency. For obstructions which are extrinsic, due to inflammatory conditions about the ureter or compression of the ureter, relief by ureter catheter may not be so readily given, and these may at times require immediate operative interference. If the condition is bilateral, whether due to intrinsic or extrinsic cause, and cannot be relieved by passage of ureteral catheters, an urgent surgical operation to relieve the obstruction or to drain the kidney so as to save the patient's life is usually indicated. If infection is superadded to unilateral obstruction, and the ureteral catheters cannot pass the obstruction, a grave emergency arises, and the obstruction must be relieved at once or a nephrostomy be performed. The latter will be necessary only in those cases where the obstruction cannot be readily reached and relieved. Furthermore, bilateral obstruction in the upper urinary tract with superadded infection under the same circumstances, that is, inability to pass the obstruction with a ureteral catheter, leads to a most urgent condition, and the side on which the most recent attack of pain or discomfort has been experienced should be exposed and the kidney drained.

*In infections of the kidney*, the so-called blood infections, usually due to staphylococci or streptococci, a real surgical emergency at times presents itself. In the absence of obstruction to the outflow of urine from the kidney, these cases can produce symptoms of sepsis and simulate at times, especially if the abscesses are on the anterior surface of the kidney, serious intra-abdominal or intraperitoneal pathology, such as perforated gastric ulcer, acute cholecystitis or acute appendicitis. Only a short time ago, this type of so-called hematogenous kidney infection was regularly operated on and a nephrectomy performed. During recent years, we have become much more conservative and when the diagnosis has been definitely established, it has usually been possible in the absence of obstruction to save the kidney by a decapsulation with or without multiple incisions of the suppurating foci in

the cortex of the kidney. At times, the diagnosis of this condition is very difficult. In the absence of urinary changes, absence of positive stone shadow and ureteral obstruction, and in the recognition of curvature of the spine to the opposite side, as well as obliteration of the lateral margins of the psoas muscle on the side of the abscess, associated with local exquisite tenderness or shock tenderness, one is justified in exposing the kidney and attempting to save the same, even in the presence of a positive blood culture. The wound is usually left wide open after the decapsulation, and a rubber dam placed in front and behind the kidney. If the patient does not improve rapidly, which is the usual course of events, a secondary rapid nephrectomy is readily executed, as the kidney lies free in the bottom of the wound.

As opposed to the infections by the cocci, bacillary renal infections, even when associated with bacteræmia, are much less serious conditions as a rule and rarely require operative interference such as decapsulation and incision of cortical foci. Some of these severe infections may well be a combination of cocci and bacillary invasion. In the so-called pyelitis of late pregnancy, ureteral indwelling catheter may suffice to tide over the worst cases, usually surgical interference of any sort is not required.

Closely related to these types of infection are those rare cases of infarcted kidney, usually associated with some cardiac disease, in which the main artery to the kidney is blocked. This may produce a picture of profound shock and even if the embolus is aseptic, if the main branch of the renal artery is blocked, an urgent nephrectomy may become necessary. The diagnosis of this condition is particularly difficult, but the absence of all secretion from the catheterized ureter would suggest such a pathology.

*Spontaneous hæmorrhage*—This type of severe hæmorrhage occurs in the upper urinary tract in tuberculosis of the kidney, tumors of the kidney and its pelvis and in such rare conditions as peri-arteritis nodosa and those cases grouped as essential hematurias. Occasionally, though rarely, such hæmorrhages may be very profound, so that the surgeon may be forced to do an urgent nephrectomy, after cystoscopical examination has shown that the other kidney is secreting normally. Usually, however, with transfusion and irrigation of the bleeding side with various antiseptics, as well as adrenalin, the bleeding can be controlled, especially if transfusion has been given. In recent years, nephrectomy for such acute hæmorrhage, as an emergency operation, has not been necessary.

In the lower urinary tract, obstructions, infections and hæmorrhages also may lead to acute emergencies, which are usually relieved by simple measures, such as the passage of a catheter, and by leaving the catheter as indwelling. In impassable obstructions with retention, an urgent bladder puncture or some type of cystotomy is demanded. Hæmorrhages are usually controlled, as well as infections, if the latter is still within the lower urinary tract, by non-operative, instrumental measures, such as evacuation of clots, irrigations with hot solutions, and the use of indwelling catheter. Rarely in uncontrollable bladder bleeding, a cystotomy and firm packing of the viscus are essential.



If, however, the infection has spread and led to a perivesical, peri-urethral, prostatic or periprostatic abscess, or extravasation, such conditions may require urgent interference to save the patient's life and prevent further destruction of the tissues of the perivesical or pre-vesical space

When we consider the traumatic conditions which may lead to urgent surgical interference, we must bear in mind that the trauma may be from within, that is, due to some pathological condition which the patient is carrying, such as calculi, or it may be caused by forces from without, whether instrumental or in the nature of contusion, *etc*, to the body. In some rare conditions, especially when there is disease in the upper urinary tract, as in hydronephrosis, polycystic kidneys and the like, an obstruction of a ureter by passage of a calculus may lead to a rupture of an infected hydronephrosis or an infected polycystic kidney. As a result of the rupture, an acute surgical condition develops, which has to be met by an urgent drainage operation. Such spontaneous ruptures, due to stones passing down the ureter, are unusual, but in a large clinical experience, every once in a while one encounters such a condition, which demands immediate surgical interference. The recognition of the exact type of pathology and complications which have developed which make the operation urgent may be far from simple, but with the use of excretory urography every once in a while, one is able to visualize the exact condition, provided the kidney function is adequate. Retrograde pyelography with one of the iodine contrast substances, preferably skiodan or uroselectan, will also help clarify the exact pathology, so that one is not compelled to make a long search after opening the patient to determine the diagnosis and exactly what one must do. With the diagnosis made pre-operatively, the emergency operation is carried out expeditiously and intelligently with a thorough meeting of all the indications.

So far as injury from without is concerned, excluding instrumental injury, which is less and less frequently seen in the upper urinary tract as a result of impaction of the ribs against the more or less distended kidney, the latter is liable to be ruptured and torn. The tears usually radiate from the pelvis into the cortex, and if the blow is a moderately severe one and the kidney has not been the seat of a pathological change, hydronephrosis, polycystic kidney or tumor, the chances are that the bleeding which follows the trauma will gradually cease and no operation will be necessary. If, on the other hand, the blow has been a more severe one, and the bleeding continues, the anæmia becomes more pronounced and the blood-pressure drops, despite intravenous glucose, as well as blood transfusion, one may be forced to do an exploratory operation which may lead to a nephrectomy or a partial nephrectomy or a reconstruction operation on the torn organ.

If, on the other hand, the kidney has been the seat of such conditions as were just mentioned, it will usually be necessary to remove the kidney. Such an operation is usually not immediately indicated, as the patient is in shock and has to be brought out of shock and treated expectantly. It rarely is an emergency in the sense that the acute gastric perforation or duodenal

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perforation is an emergency. When the decision is reached that the bleeding is uncontrollable, such a case demands an expeditious procedure.

Trauma to the ureter itself, tearing of same, is rarely seen, except in extensive fractures of the pelvis and these cases, just as many of the kidney cases, usually have associated intraperitoneal injuries such as splenic, hepatic or intestinal ruptures.

Rupture of the bladder, due to trauma from without, is a much more common accident since automobilism has become popular. Patients under the influence of alcohol, with their bladders full of urine, are particularly prone to this very serious accident. These ruptures, as is well known, may be extraperitoneal or intraperitoneal, and in the future may be recognized more readily with the use of intravenous or excretory urography, which will show the iodine solution either in the perivesical space or intraperitoneally. As yet, only a few pictures of this type of damage have been published (with excretory urograms). Another aid in diagnosing rupture of the bladder is by passing a catheter, obtaining blood, and then injecting sterile CO<sub>2</sub> through the catheter. If the perforation is intraperitoneal, the CO<sub>2</sub> will rise under the diaphragm and be easily seen on a film or fluoroscopically, or if the patient is placed in the lateral position, it will be seen on the uppermost side under the parietes of the abdominal wall. If, on the other hand, the perforation is extraperitoneal, the CO<sub>2</sub> will collect in the perivesical tissues running up towards the navel. Cystoscopic determination of a rupture of a bladder or filling of a bladder and trying to recover the same amount of fluid as has been introduced are not to be recommended, and are not reliable, as one can, despite the fact that there is a fair-sized opening in the bladder, cystoscope the patient and not see the tear or opening, and one may recover the introduced fluid at times with perfect ease.

The local signs of irritation, peritoneal or perivesical, together with blood in the urine after severe injury, especially if one is fortunate enough to get an excretory urogram showing extravasation of iodide in the perivesical space or in the peritoneal cavity, creates a real surgical emergency, which should be immediately met with suprapubic drainage and wide drainage of the perivesical space after suture of the intraperitoneal or extraperitoneal tear. If the bladder has been torn from the urethra, an indwelling catheter should be left in while suprapubic drainage is also carried out. If bones have been broken in the pubic region, this area should be protected with rubber dam, so that necrosis of the bone is minimized.

Trauma to the urethra in the penile portion is less common and less serious than in the deep urethra, where the injury is frequently produced by falling astride a hard object or by a severe and serious blow to the pelvis. In these cases, if the urethra is blocked to the passage of an instrument, and it has not been the seat of a previous contracture, immediate perineal section is indicated with intubation of the urethra by an indwelling catheter and the urethral ends approximated after débriding the lacerated urethral tissues.

Extensive incisions in the perineum and adjacent parts must be made to relieve extravasation, especially when complicated by infection

In view of the fact that in many of these cases of injury from without the previous condition of the urinary tract is not known, and in view of the fact that the injury may be in the nature of serious contusive force all these patients should be given the benefit of tetanus antitoxin and gas-bacillus antitoxin, after testing out the sensitivity in the conjunctiva

If we look back over these various groups of cases, it becomes evident that in the traumatic cases, the modern developments in urology have helped clarify the diagnosis, so that the surgeon in emergency may act with more intelligence than twenty-odd years ago, and when we consider the non-traumatic cases, it becomes more clear that the large group of cases which used to be considered emergency surgical procedures have, due to the advances in urological surgery, become amenable to instrumental, rather than cutting, procedures

# ACUTE OBSTRUCTING AND INFLAMMATORY LESIONS OF THE KIDNEYS AND THE URETERS

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EMERGENCY operations on the kidneys and ureters are usually performed because of obstructing lesions interfering with the adequate passage of urine. Symptoms of localized or generalized infection may occur because of pyelovenous backflow, the result of overdistention of the renal pelvis, or absorption of toxins or bacteria from severe cortical infection, especially abscess. In these cases the relief of the obstruction, either by direct removal of the obstructing lesion, or removal of the accumulation of urine above the obstruction, is absolutely necessary. Delay in carrying out such procedures may mean the loss of the kidney and possibly the patient. If the infection in the kidney is severe and associated with bacteræmia or septicæmia, nephrectomy is necessary immediately.

*Hydronephrosis*—If the obstruction of the upper portion of the urinary tract is intermittent and incomplete, hydronephrosis results frequently without symptoms of a systemic infection. For example, in the case of a young woman recently operated on, hydronephrosis had appeared subsequent to injury of the right ureter during operation for the removal of what was reported to be an extensive malignant lesion of the right ovary. The resulting urinary fistula persisted for four months, and a year later the right kidney became enlarged and painful. Apparently it did not increase in size during the succeeding twelve months. When nephrectomy was performed, 95 per cent of the renal parenchyma had been destroyed, and when the kidney was emptied of approximately 400 to 500 cc of infected urine, its shell weighed only fifty-five grams. In all probability, the obstruction to the right ureter was incomplete.

In contrast to the foregoing is the course of events in the presence of complete obstruction, but for a period insufficient to produce destruction of the renal parenchyma, yet long enough for the renal pelvis to become markedly dilated. Temporary nephrostomy performed under local anæsthesia will relieve the obstruction and the stones can be removed later. In such a case, even though from 200 to 300 cubic centimetres of purulent white urine drained from the kidney immediately, study of renal function by intravenous urography twenty-eight days later gave evidence of but little residual dilatation of the pelvis and calices and an apparently normally functioning renal parenchyma. The establishment of renal drainage might have been as satisfactorily accomplished in this case by primary removal of the obstructing lesion (a calculus), but I have operated in cases in which it became necessary within a few days to remove the kidney because it was seriously infected.

*Whether to Remove the Obstructing Lesion or Perform Nephrectomy or Nephrostomy?*—In general, it may be said that when enough renal parenchyma remains to justify the assumption that it is worth preserving, the proper surgical procedure should be directed toward relief of the obstruction and preservation of the kidney. This may be accomplished best by the removal of the stone or stones, performing at the same time temporary nephrostomy to assist in more perfect drainage. Such procedure should be carried out particularly if the obstructing calculi are within the kidney or in the upper portion of the ureter so that the kidney is made easily accessible for nephrostomy.

On the other hand, when the completely obstructing lesion is in the lower part of the ureter, and an emergency operation is necessary, nephrostomy may be the simplest and safest procedure until the condition of the patient improves to the extent that the removal of the obstruction can be carried out safely later, when the toxæmia has subsided. For example, in one case a small left ureteral calculus became impacted in the lower portion of the ureter subsequent to an unsuccessful attempt to remove it by manipulation of a catheter through the cystoscope. Intermittent fever and prostration necessitated immediate relief of the obstruction. The small size of the stone, its situation in the vesical portion of the ureter (the most difficult site for surgical removal of a small stone) indicated the advisability of draining the kidney. This was successfully accomplished by temporary drainage of the renal pelvis, the patient's fever subsided, his general condition improved, and when the toxæmia had disappeared, the stone was successfully removed by catheter.

When renal parenchyma is involved to the extent that cortical abscesses have formed, nephrectomy may be necessary, even life-saving, especially if there is evidence of the presence of bacteræmia. In the absence of systemic infection, provided sufficient renal parenchyma remains, one is impressed with the satisfactory restoration of renal function and the subsidence of infection which occurs following removal of obstructing renal calculi and complete drainage of the kidney by temporary nephrostomy. Such methods have been of great value in the treatment of multiple, renal, bilateral calculi which produce infected hydronephroses, as illustrated in the following case.

Both kidneys of a woman, aged thirty-nine years, were obstructed by multiple calculi to the extent of causing infection in the hydronephrotic sac, and fever of  $104^{\circ}\text{F}$ . Marked tenderness to pressure was noted about and over the right kidney and infection to the perirenal tissues was extensive. Right pelviolithotomy was done, with removal of seven stones, the largest of which was 4.5 centimetres in diameter. The cortex was infected, and creamy, purulent urine spurted out under great pressure when the pelvis was opened. Two months later, a similar procedure was carried out on the left kidney. The nephrostomy catheters were removed and the patient recovered satisfactorily. In spite of the fever and the apparent disturbance of renal function prior to operation, the patient did not appear to be toxic, and the blood urica was within normal limits. Such factors in these cases must be of considerable prognostic significance.

In one case in which the obstruction was due to two stones in the right ureter,

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multiple small cortical abscesses were present in the kidney without producing evidence of systemic infection. After removal of the stones and drainage of the kidney by allowing the incision in the ureter to remain open temporarily, function of the kidney was restored to the extent that two weeks later the incision had healed and the kidney was outlined and excreting a moderate amount of skiodan. In other words, a badly infected kidney containing cortical abscesses usually should be removed, particularly if systemic infection is apparent, provided the condition of the other kidney is adequate to carry on renal function. One is tempted to preserve such a kidney when systemic infection is not present, especially if the condition of the opposite kidney is uncertain.

*The Effect of Ureteral or Renal Obstruction on the Solitary Kidney—* A normally functioning kidney will maintain adequate function even in the presence of complete obstruction of the other kidney. Any evidence of renal insufficiency in a case in which obstruction of but one kidney is apparent indicates that the function of the other kidney probably is not adequate, and hence every effort must be directed to relieve urinary obstruction without sacrificing the obstructed kidney. Hence, when in doubt, perform nephrostomy rather than nephrectomy.

I observed noteworthy exceptions to this rule in a case of perirenal accumulation of urine following the rupture of a hydronephrotic kidney, the parenchyma of which had become infected. The clinical picture was that of peritonitis, except for extreme tenderness on pressure over the left kidney. The concentration of urea of 180 milligrams in each 100 cubic centimetres of blood was apparently due to the intestinal stasis secondary to the retroperitoneal infection, or to protein destruction (the amount of urea was greater than normal, 117 grams passed in the urine each twenty-four hours). Following nephrectomy and drainage, the patient continued to improve, and he recovered completely, which would not have been the case had function of the opposite kidney been inadequate.

Another important exception occurs in cases in which a stone or stones in one kidney may interfere temporarily with its function so that an acutely obstructing lesion of the opposite kidney or ureter may be accompanied by anuria, yet after the removal of the stones function of both kidneys returns.

In one case, that of a woman, a large stone suddenly obstructed the right ureter and the patient became anuric. Rontgenograms disclosed this stone, and two stones in the left kidney. Anuria had been present for twenty-four hours prior to examination. The concentration of urea was eighty-four milligrams in each 100 cubic centimetres of blood, pus and blood were found in the urine. A catheter was inserted up the right ureter past the stone, which temporarily relieved the obstruction of the right kidney. An intravenous urogram disclosed right hydronephrosis with stone in the right ureter. The left renal pelvis or ureter was not visualized. Stones occluded the left renal ureteropelvic juncture. Right ureterolithotomy was performed October 6, 1932, and approximately a month later, left pelvolithotomy. Two stones were removed, one 3.5 by 2.5 centimetres and the other 2.5 by 1.5 centimetres, from the left kidney, the renal parenchyma of which appeared to be reasonably normal. An uneventful convalescence followed. November 24, 1932, the blood urea was normal. An intravenous urogram disclosed dilatation of the right pelvis and calyx, graded 3, and dilatation of the left pelvis and calices, graded 1. In commenting on the urogram, Braasch stated "Remarkable restoration of function of left kidney following pelvolithotomy." This would lead to the assumption that a stone or stones in a kidney may temporarily interfere with its function without permanent injury of the parenchyma of the kidney, and the kidney itself might be said to be resting.

*Perinephritic Abscess*—Irregular fever, tenderness and induration in the perirenal area, leucocytosis, roentgenological evidence of scoliosis, and obliteration of the outline of the iliopsoas muscle on the tender side, is the clinical syndrome indicating perinephritic abscess, and exploration of the perirenal region is indicated. I can recall scarcely a case in which exploration on such evidence did not reveal abscess. Secondary nephrectomy is seldom necessary in such cases. When to perform nephrectomy can be determined by observing the degree of infection and function by cystoscopy or urography prior to or following drainage of the abscess. There is always the slight possibility that an abscess about the left kidney may be due to retroperitoneal extension of an infected carcinomatous growth of the descending colon. I have operated in two such cases, in both of which a diagnosis was made on microscopical examination of the removed tissue but only after secondary exploration of the persisting sinus.

*Intrarenal Hæmorrhage*—In general, although intrapelvic renal hæmorrhage occurs when tumors are present in the kidney, it is seldom if ever necessary to perform emergency nephrectomy because of sudden serious hæmorrhage due to such a cause. There may be serious bleeding from the kidney or ureter subsequent to operation on the renal parenchyma, such as nephrolithotomy, and in rare instances following pelviolithotomy or ureterolithotomy.

Such a complication occurred in one of my cases following simple pelviolithotomy, and secondary nephrectomy was necessary, the kidney contained multiple renal infarcts. In another case serious bleeding followed removal of a gauze pack, inserted into the renal substance around a large de Pezzar catheter to control bleeding from a large opening made in the parenchyma of the kidney to remove an egg-shaped stone measuring five by four centimetres. The bleeding was successfully controlled by mattress sutures in the renal parenchyma. In a case in which I removed a very large stone from the lower third of the right ureter, there was rather serious bleeding from it into the bladder. Evacuation of blood-clots in the bladder through a cystoscope had no effect on the bleeding. The bladder was opened, and a No. 14 urethral catheter was passed up the ureter. At a point above the approximate area from which the ureter had been incised for the removal of the stone, considerable turbid urine was encountered. The obstruction caused by the blood-clots in the lower part of the ureter, distal to the ureterolithotomy incision, was relieved, and bleeding from the ureter ceased spontaneously within a few hours.

In the case of a patient, aged sixty-four years, from whom I removed a large, solitary, renal cyst, bleeding into the renal pelvis was continuous and necessitated nephrectomy seven days later. Although healing was excellent at the site of the resection, large sclerotic branches of the renal artery were found and apparently explained the cause for bleeding, the corollary of which would seem to be that plastic operation on the renal parenchyma of an elderly patient with arteriosclerosis may not be successful.

Another condition in which intrarenal hæmorrhage may occur and necessitate immediate surgical interference is polycystic kidneys in which massive hæmorrhage may occur into the cysts either spontaneously or the result of trauma to the kidney. In such cases, nephrectomy may be advisable if the function of the opposite kidney is adequate, if not, the operation described

by Rovsing of puncture collapse of the cysts or enucleation is surprisingly successful in prolonging life in many cases

In a group of eighty-three cases in which operation was performed at The Mayo Clinic because of symptoms developing from polycystic kidneys, nephrectomy was carried out in thirty-one, usually because of severe infection. The Rovsing operation or excision of some of the cysts was performed in twenty-nine cases, with an exceedingly low mortality rate and with surprisingly long periods of life in many cases. The most important factor in the determination of the choice of the Rovsing operation or nephrectomy, as one would expect, depends on the function and degree of infection in the kidney operated on, but especially on the ability of the remaining kidney to carry on adequate renal function.

*Injury to the Kidney Producing Intrarenal and Perirenal Hæmorrhage* — I shall refer only briefly to the indications for emergency surgical procedures in the treatment of the contused or fractured kidney. In general, it can be said, however, that many contused kidneys heal spontaneously. Rupture or tearing of the renal vessels necessitates immediate nephrectomy and tearing of the renal pelvis necessitates perirenal drainage. Intravenous urography has been of great aid in localizing the point of fracture. As a rule, when the condition of the patient indicates accumulation or extravasation of either blood or urine about the kidney, or continuous bleeding into the urinary tract, producing general symptoms of progressive, depleting hæmorrhage, surgical exploration of the kidney should be carried out.

*Summary* — Emergency operations on the kidneys and ureters are usually performed because of obstructing lesions interfering with the adequate passage of urine. The association of renal infections with obstruction produces symptoms characteristic of toxæmia, the result of pyelovenous backflow or absorption of toxins and bacteria from severe cortical infections, usually with abscesses.

Striking examples of the restoration of renal function after the removal of renal and ureteral calculi and complete drainage of the kidney by temporary nephrostomy are convincing arguments in favor of such conservative methods of caring for such lesions, rather than treatment by nephrectomy. This is true in most cases even when there is considerable infection within the renal pelvis (infected hydronephrotic sac) and occasionally within the renal parenchyma. However, if the kidney is producing general evidence of severe infection and toxæmia, and the opposite kidney is normal, immediate removal of the kidney is usually essential to the recovery of the patient.

One normally functioning kidney will maintain adequate renal function in the presence of complete obstruction of the other kidney. Hence, any evidence of renal insufficiency in such cases indicates that the function of the other kidney is not adequate. There are a few exceptions to the rule, but when in doubt nephrostomy rather than nephrectomy is the advisable procedure.



Perinephritic abscess is characterized by a typical clinical picture consisting of pain in either renal area, fever, leucocytosis, tenderness to pressure, and in most cases by scoliosis with obliteration of the line of the ileopsoas muscle on Rontgen examination. Surgical exploration of the perirenal region in such cases is always advisable.

Intrarenal hæmorrhage requiring emergency surgical procedures is of infrequent occurrence, but may occur in cases of traumatic fracture of the kidney or its vessels, or rarely following operations on the kidney.

DISCUSSION—DR WILLIAM F. BRAASCH (by invitation) (Rochester, Minn.) noted that adequate drainage can frequently be established by means of the ureteral catheter. Furthermore, nephrostomy or pyelostomy will give the desired drainage. With acute cortical infection, however, neither catheter drainage nor nephrostomy will correct the condition and immediate nephrectomy is advisable. If on exploration of the kidney many small abscesses are found scattered over the entire kidney, the question may well be asked, if the other kidney is similarly affected would nephrectomy be advisable?

The clinical diagnosis of cortical infection may be difficult. Often the evidence of toxæmia is the best guide. The patient has a toxic appearance and will complain of headache and stupor. There may be no localized tenderness or pain in the region of the affected kidney. A blood culture may be of considerable aid, but often one does not want to wait twenty-four hours for the report. He had frequently seen blood cultures that were quite unsatisfactory. In some cases the report would suggest the possibility of contamination and it would be necessary to wait another twenty-four hours. He had also observed negative blood cultures where he knew there was a systemic infection.

In cases of doubt it would be conservative surgery to take the kidney out in order to prevent the possibility of secondary infection via the blood-stream going to the other kidney.

This course would be preferable to waiting until the other kidney becomes involved as shown by increase in blood urea and death. On autopsy cortical infection is usually found in the other kidney, which often would not have occurred if the primarily infected kidney had been removed earlier.

Another phase which both Doctor Walters and Doctor Beer brought up is that they have demonstrated how dependent we are these days upon intravenous or excretory urography. The general surgeon has been very slow in adopting this most valuable adjunct in the diagnosis of renal conditions, probably for various reasons. One reason is that he apparently felt it was within the exclusive province of the urologist. The speaker did not think it is at all. Intravenous urography is a method of general diagnosis and should be employed more generally, and undoubtedly will be in the future. The only difficulty is the matter of interpretation. With increasing familiarity with interpretation of the intravenous urogram, the method will be employed in routine differential diagnosis of abdominal disease. More and more diagnoses are being made by the country practitioner by means of this invaluable method.

There are, however, some complications involved in its universal use. There are many difficulties in the way of accurate interpretation. It will also be found that data given by the cystoscope will often be necessary. Among the difficulties in interpretation is the absence of visualization caused by reflex inhibition of excretion, which was emphasized by Doctor Walters and Doctor Beer. In some cases with renal stone it is curious to see how the kidney will show absolutely no visualization in the excretory urogram, while the other kidney is clearly visualized. On surgical exploration the kidney involved is often found to be normal. It is difficult to explain this on physiological grounds, but it is apparently the result of temporary inhibition of excretion or the result of irritation from the calculus.

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The method has proven to be of great value in our evaluation of post-operative results. He would give warning, however, that one should not expect too much from intravenous urograms made within a week or ten days after operation on the kidneys. A reflex inhibition of excretion often persists for several weeks. If taken in two weeks or a month later most interesting data are often available, which could be acquired in no other way.

Intravenous or excretory urography will be of greatest value to the surgeon in the interpretation of X-ray shadows, in determining the position of the stone in the kidney, and in ascertaining the function of both kidneys. Next in importance will be its aid in the demonstration and visualization of stasis. In those two things it will be unquestionably of great value to the general man. It will also be of great value with injuries to the kidney. We have been able to determine not alone rupture of the kidney but also its degree, from the evidence of extravasation of urine into the surrounding tissues. Rupture of the bladder is much better demonstrated by means of the intravenous cystogram than in any other way. In this way the danger of ascending infection from catheterization is obviated.

DOCTOR BEER said, in closing, members of this society are doing kidney surgery. Doctor Walters and Doctor Braasch have just called attention to a possible pitfall which would mislead the uninitiated to take out a kidney which is obstructed by a stone in the ureter. It has been known for years that a stone in the ureter may inhibit such kidneys. A catheter passed up to the stone may fail to collect a urinary specimen and one would have the impression that the kidney was definitely not functioning. As a matter of fact, an intravenous urogram in many of these cases may show that there is no function. The general surgeon might, not knowing this pitfall, cut down on the kidney to inspect it and perhaps remove it.

He thought the rational thing to do in these cases of so-called "resting kidney," or "hibernating kidney" is to take out the obstructing stone. He did not believe they are either resting or hibernating, but are secreting all the time though one cannot collect a specimen. He had made use of intravenous indigo on the table in this case and passed the catheter up to the pelvis, through the ureterotomy incision, and obtained good indigo secretion while the patient was still under the anæsthesia. In other words, the kidney was proved to be functioning well, though they were not able with their methods to collect specimens below the stone.

Every abdominal case that is not clear-cut should have a flat plate, an intravenous urogram, a gall-bladder series and then a gastro-intestinal series so as to clear up the three tracts in the abdominal cavity with which one has to deal and which one has to treat.

## ANATOMY ECLIPSED

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WHEN a source of light which for ages has illumined our steps is eclipsed by another celestial body, it is natural that we should feel disturbed, and even though the newcomer has a radiance of its own, that we should inquire whether we are better or worse off, and whether we might not have the benefit of both luminaries to make clear our perilous path. That the anatomy of the medical curriculum has suffered a partial eclipse, and that its obscuration is increasing are so evident that it is incumbent on those charged with the responsibilities of medical education, as are the Fellows of the American Surgical Association, to examine the situation and register their approval or disapproval of the change which is taking place.

If a text were needed to introduce this subject, it might well be taken from Thomas Vicary, who in 1577 wrote or published the first book on anatomy in the English language. Said Vicary "The Chirurgeon must knowe the Anatomie, for all authors write against those surgeons that work in man's body not knowing the Anatomie for they be likened to a blind man that cutteth in a vine tree, for he taketh away more or less than he ought to do." Quaint and old-fashioned this sentiment sounds, yet most medical men, and their patients also, I fancy, would recognize in it a principle, fundamental and as immutable as anything can be in this changing world.

From the beginning of organized medical education until a period within the memory of living men, anatomy was not only the fundamental, but the sole laboratory subject. The study of form and structure must precede that of function, and both together must be antecedent to the study of perverted form and function—in other words, of pathological anatomy and physiology. These elder daughters were long the chief support of Mother Medicine's family, but she has been prolific, and many other offspring have been born, the end is not yet, and these newcomers are lusty youngsters who, like most self-confident adolescents, are not conspicuously aware of the rights of others, and are apt to crowd and jostle their elders as they seek their rightful places in the sun. The two younger of the elder trio, pathology and physiology, are still growing, the latter indeed with no evident slackening of pace, the eldest, however, is quite matured and though just as useful as ever in the family economy, is thought by some to be old-fashioned and out-of-date and is in danger of being neglected. She has children of her own, by the way—first, histology and embryology, and then a flock of later arrivals such as comparative morphology, cytology and experimental embryology, all promising youngsters who are adding much to the family reputation, but who are necessarily crowding the old home and claiming all of the family income they

can get And unfortunately the eldest sister, anatomy, cannot be dispossessed because though neglected, she is perfectly certain to live just as long as Mother Medicine herself

No intelligent man even a jealous lover of anatomy, can deny that the newer sciences, as they crowd into a curriculum which has about reached its limit of accommodation either by extension of time or by a tabloid-like compression of substance, have in general established their claim to receive every reasonable consideration Anatomy, having once and for a long period comprised the whole of the science underlying the art of medicine, finds itself of much less importance *relatively*, but is its value not just as great as ever *intrinsically*? The student in the dissecting room enters upon a discipline of incalculable value, where not only the knowledge gained is an end in itself but where the method used requires that he become an independent investigator, training both his senses and his faculties of observation and acquiring skill in the use of instruments Says Macalister "I believe that training in careful dissections is still the best discipline," if the student is "not willing to accept the words of the text-book until he verifies them by comparison with the facts "

Who shall teach anatomy? Formerly the chairs of Anatomy and of Surgery were combined and held by the most conspicuous practitioner of the community, later the chairs became distinct although the Professor of Anatomy was usually still a man in active practice, finally, since the growth of the full-time principle in laboratory and even in clinical subjects, the anatomist in the most richly endowed schools has become a pure laboratory worker, with no clinical contacts, and sometimes even without the experience gained from a hospital internship, if indeed he ever studied medicine at all! His assistants of varying grades, depending on the ability of the school to pay full-time salaries, are likely to consist of one or several men preparing themselves for advancement in the same path trodden by their chief, and of a larger number of young men in active practice, who see in the part-time job as assistant in the dissecting room, ill-paid though it be, an opportunity worth taking for a year or two, of brushing up their anatomy and trying themselves out as teachers It is idle to pretend that as a rule the men who seek these minor posts are the equal of their fellows of former years, when the pick of the young men in a medical community who nursed high ambitions to excel in surgery competed for such positions and found in long-continued work in the dissecting room an experience which made them competent, safe, and daring in the performance of surgical operations, and was the surest way of attaining preferment alike in clinic, in practice, and in surgical teaching Any of us who were educated in the "'nineties" need only to think of our instructors in anatomy to be reminded of the surgeons who became leaders in our communities

Related to the question as to who shall teach anatomy, and how, is the query as to just what anatomy shall be taught in the regular curriculum It is the fashion to disparage systematic descriptive anatomy, and certainly

there is scarcely any subject in which it is more important for the teacher to have a knowledge of the values and perspectives, the lights and shades, of his subject. It is dangerous, however, to assume that anything in gross anatomy is unimportant, for the development of surgical therapeutics shows a constant trend toward appropriation of new fields where an accurate anatomical knowledge is indispensable. An obvious example is furnished by the sympathetic and parasympathetic nervous systems largely neglected in our day because their function was ill-understood and the relief by surgical measures of their dysfunction was not attempted, but now the subject of an enormous literature and of numerous operative procedures. Another example is the skeletal muscular system—we will all agree that a meticulous knowledge of the exact origin and insertion of each of the 500-odd skeletal muscles is unnecessary, but we must also own that a good working knowledge is essential in the diagnosis and treatment of fractures and in the muscle and tendon transplantations so skilfully used by orthopædists for the relief of paralyses and contractures. Still another instance is the accurate and comprehensive knowledge of morphological osteology and of visceral topography which is needed by the radiologist for the interpretation of films. The internist who makes lumbar, cistern, and sinus punctures, performs paracentesis on pleural, pericardial and abdominal cavities, does vein-puncture and intramuscular injections, needs much beside the accurate knowledge of visceral topography which has always been essential to him. In fact, whatever the relative importance of gross anatomy in the hierarchy of medical studies, it becomes steadily of greater intrinsic value with the advance of medical science.

There are arguments, or rather assertions, to the contrary. We are all familiar with the sage who says that a surgeon can learn all the anatomy he needs on his patient—all *he* needs perhaps, might be rejoined, but not all the patient needs! Maurice H. Richardson, a former President, said before this Association in 1902: "I have heard a surgeon of large experience say that a knowledge of anatomy is bad for the abdominal surgeon because it makes him timid,—it makes him bold! *He* can be bold and rapid if need be, when the man who despises anatomy could without disaster be neither." It may be true, of course, that in this era of intense specialism, surgeons who prefer and find themselves able to confine their work to a topographically small anatomical field gain by intensive study and experience during post-graduate years, whatever knowledge of anatomy they require, unless indeed an unkind Fate introduces, as she may now and then, a complication requiring prompt action in an unfamiliar field. The plea of the specialist, however, is hardly justification for cutting down the required anatomy at the beginning of a student's career! As well debar a youngster from learning to write because he may employ a stenographer when he is grown up!

Opportunities other than in first year descriptive anatomy are offered in many schools, as for example exercises in topographical anatomy, which differ from the descriptive ones only in method, and courses in surgical or applied

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anatomy, which are frequently offered, usually as electives or as voluntary extra work. A course in applied anatomy, given preferably by an experienced surgeon, may constitute the most important and significant experience of a student in the whole field of anatomy. Courses in operative surgery on the cadaver, given as they often were by surgeons and teachers of distinction, were of the utmost value in preparation for the surgery of the pre-Listerian era. But ligations of vessels in continuity, amputations, incisions of abscesses and removals of the breast constitute the least important part of the surgery of today. The cadaveric lack of bleeding, the absence of retractility and elasticity of the divided tissues—and the total absence in the cadaver of the conditions and difficulties which confront the surgeon when he invades the abdominal, thoracic, and cranial cavities impair seriously the usefulness of this discipline, which is afforded to much better advantage in the animal laboratory, or better still, in the apprenticeship under responsible supervision in a hospital internship.

The study of anatomy is proverbially dry, the necessity of memorizing a great number of names, relations, forms and other facts at a time when the student has only the vaguest idea of their significance leads to boredom and lack of interest. If the systematic instruction is given by a professor who has no clinical experience, who knows only from hearsay—if at all—and is not concerned with the reasons why anatomical facts are of importance to the practicing physician or surgeon, whose real interest and enthusiasm lie in the field of comparative morphology or experimental embryology, it can scarcely be expected that the subject shall be presented in a stimulating, interesting and profitable manner. It is unwarrantable to assume that junior instructors, teaching in sections, ill-paid and lacking in experience as teachers, will assure the entire class of receiving what they ought to get from a senior member of the department.

The failure to teach the significance of gross anatomy instead of its bone-dry facts is well illustrated by some correspondence which may be summarized from the files of the *ANNALS OF SURGERY*. In June, 1926, Dr Hermann Fischer, in discussing a paper by Dr Fordyce B St John on biliary fistula, called attention to the troublesome character of hæmorrhage from the cystic artery and the difficulty of securing it. He described an effective method of controlling it by placing the left index finger in the foramen of Winslow and hooking up the structures (including the hepatic artery) which run in the free edge of the gastrohepatic omentum. He stated that he had not seen this simple method described in text-books. This communication inspired a letter from Dr F H Parham, of New Orleans, which stated that in *Surgery, Gynecology and Obstetrics* for September, 1925, would be found an article by Dr Duncan Parham describing in detail the same procedure "which had accidentally occurred to him in a demonstration on a dog," and the feasibility of which he further proved by animal experimentation. Subsequently, in an instance where failure to secure an anomalous cystic artery resulted in alarming hæmorrhage, he had successfully extricated

the patient from a dangerous situation by the same expedient. Doctor Parham further stated that a search of the literature failed to find any reference to such a manoeuvre.

Is not this a deplorable state of affairs? Three highly competent surgeons had never been helped in their student and interne days to a realization of the practical significance of the course and relations of the cystic artery, to the end that the knowledge might be available in emergency. Is it not almost the sole reason why a student should dissect, examine and study the relations of the cystic artery that he may understand its significance in lesions of the gall-bladder and ducts, and be able to avoid or discover it, or control accidental hæmorrhage from it if wounded?

It is interesting to inquire just who is teaching anatomy in our schools. Examination of the latest announcements of fifteen institutions which would, by common consent, be ranked as leaders in medical education, shows that in the majority the teaching is under the direction of laboratory anatomists who hold no degree in medicine, or who if they do, have had little or no clinical experience. In most instances the heads of the departments teach the branches of embryology or histology or both. In two schools the teaching of gross anatomy is entirely in the hands of Doctors of Philosophy and Bachelors of Science, in four the preponderance of this element is very great, constituting approximately three-fifths or four-fifths of the teachers of professorial calibre. It is relatively uncommon to find men in the higher grades who, if they have degrees in Medicine, have also important clinical experience. In one school are found three full professors in the fields of comparative anatomy, embryology, histology and cytology, not one of whom has ever seen a sick person since he graduated in Medicine, the gross anatomy is in charge of an Assistant-Professor—competent indeed, but so ill-paid that his time and energy must be largely devoted to earning his living by other means. In one school there appears to be no requirement that the gross anatomy of the entire body be systematically taught, though an examination in the subject must be passed. In another school the dissection of the extremities is optional, leading to the inference that its graduates had better be excused from treating conditions other than those affecting the trunk, head and neck. It is understood, of course that in almost all of these schools there is oversight and quizzing in the dissecting room by young clinicians but it is only too certain that these men receive but pitiful compensation—so small that only the rare man can feel much obligation to or enthusiasm for his job.

No doubt it has become difficult to find able clinicians to teach anatomy, but one reason is not far to seek. The gross anatomist, susceptible to neuroses like any one else, has developed an inferiority complex. It is not helpful to him to be told by a full-time (and fully paid!) colleague in a younger and still adolescent pre-clinical department that anatomy is dead and unworthy of so prominent a place in the curriculum. Harvey Cushing has said "More and more the pre-clinical chairs in most of our schools have come to be occupied by men whose scientific interests may be quite unrelated

to anything that obviously has to do with Medicine, some of whom, indeed, confess to a feeling that by engaging in problems that have an evident bearing on the healing art they lose caste among their fellows" It tends to create a sense of frustration in the morphological and clinical anatomist to learn from the pen of the Professor of Anatomy in one of our most conspicuous and richly endowed schools that the subject of the former's study and teaching is nothing but "fixed protoplasm," that "human anatomy was in great danger of becoming nothing more than a handmaid to Medicine and Surgery"—and that "the days when the anatomist commanded the respect and confidence of his medical colleagues solely on the basis of his knowledge of static morphology, are rapidly disappearing" Until enlightened by these pronouncements as to his true status, the anatomist had labored under the delusion that he was studying and interpreting the architecture and adaptation to function of the most marvellous of created beings, that in so doing he was laying with his students the very foundations of the science and art of healing which they were to practice, and that in proportion to his learning and zeal and devotion to his work he deserved and received the respect of his fellows If the views above quoted, circulated by the most powerful of the Foundations in the field of education, represent truly current opinion and practice, it is difficult to escape the conviction that the young surgeon, eager to enter a profitable field of teaching, to make himself serviceable, to win esteem and the preferment justly due to meritorious service, would do well to hesitate before he commits himself to more than a year or two, if even that, of anatomical teaching He may ponder and believe the words of Richardson "Prolonged dissection on the cadaver is the only real preparation for operative surgery," or the declaration of Cushing "I would say spend four years in three places—the dissecting room, the dead house and the clinic, these places represent the workshops of the three fundamental subjects from which all others have branches off, and yet they have come to be neglected",—and yet again would hesitation on his part be prudent

A phenomenon which obtrudes itself as an inevitable corollary of the eclipse of anatomy is the apotheosis of research Research practiced by the genius or even by the merely talented, yielding, as the Fates may ordain, its grains of gold for the fashioning of Truth, is indeed as nearly divine a work as human faculties can do, and deserves a place beside the gods But much masquerades as research which resembles it only in name Who will venture to say what proportion of the men who, attracted by the glamour and sometimes false prestige attending research, enter upon it, are really qualified by training, by ability, by opportunity and by singleness of purpose to pursue it? Prevailing currents of thought among medical educators and executives are largely responsible for the belief among young men that whereas the high road to success formerly lay through the dissecting room and the dead-house, now that route is out-moded and scarcely passable through disuse, and the new speedway is solely through the experimental laboratory Moreover, is it not irrational and stupid that the concept of research should be identified



solely with the laboratory? Research is much more a state of mind than it is an overt act. The physician who, by observation and correlation of the phenomena of disease and by sound reasoning draws inductions which he marshals and presents in class or forum or journal for the guidance of others—is he not engaged in research? The surgeon who, on the most precious of living subjects, applies the principles of manual therapeutics, modifying and adapting his procedures to fit the infinite variations of disease which he encounters, and records his observations and results for comparison and evaluation with others—is he not engaged in research? Edward Jenner, the general practitioner, observing facts and making inferences therefrom, made a research which protected mankind from the scourge which had periodically devastated it, Sir James McKenzie conducted the most veritable piece of research in studying, recording, classifying the symptoms and signs of patients with disordered action of the heart, and contributed a concept of its pathological physiology which has been but confirmed by laboratory instruments of precision.

Is it unreasonable to declare that gross descriptive morphological anatomy is worthy of being taught by a man of seniority and experience in teaching, of wide clinical experience, preferably in surgery, and of broad interests in the whole field of medicine, especially the fundamental sciences? It is immaterial whether he be head of the department—a matter which should depend on the relative qualities of leadership and executive ability of members of the staff. He should have full professorial rank, befitting a teacher responsible for the instruction in a major fundamental subject. His emolument should be, in theory, equal to that paid full-time teachers of equal rank, but in practice, he may be able to carry on enough clinical work, perhaps only in the University Hospital, to permit some portion of his full professorial salary to be diverted to other uses. But his prestige and salary should be such as to make it worth while for a first-class man to give first-class instruction in the most fundamental subject of the medical curriculum. Such a man, with his knowledge of physiology, pathology and pathological physiology, of clinical medicine and surgery, will quicken the dry facts of anatomy with life, and inspire students with a realization of the practical importance of what they are studying. If time permits and a teacher is available to give supplementary lectures in a philosophical vein on the implications of human and comparative anatomy in the broader field of biology, by all means let these be given. Let the Medical School be permeated by the spirit of research, but let us have no research snobs—nor any others, for that matter, let us each respect the other's fields, let us consider the research conducted in the clinic as praiseworthy and fruitful as that involving test tubes and kymographs and manipulations of ova to make monsters of embryonic batrachians, let us believe that the prime duty of a Medical School, as contrasted with a University or Foundation Biological Institute, is to prepare men to practice the art of preventing and healing disease, and let us consider that duty as outranked in dignity by no other on earth.

## ANATOMY ECLIPSED

DISCUSSION—DR. HUBERT A. ROYSTER (Raleigh, N. C.) agreed with all that Doctor Cheever had said. He had had some experience on examining boards and had made some observations. He found that even in the high-class medical schools, and the highest ones especially, the subject of anatomy is not only neglected but is ill taught. There is an intensive course in anatomy lasting five months, beginning in October and ending in February, on which the examination in some of the schools is held at the end of the second year. The students are put into the dissecting room in these very high-class institutions without any instruction whatever, no text-book, no diagrams, no explanations except a few dissecting tools which are given to them and they are asked to dissect.

The student goes in, gets off the skin very well, but if he cuts the cutaneous nerve they swear at him. They do not, however, tell him where the cutaneous nerves are.

That may be the right way. At the risk of being old-fashioned and of joining in Doctor Cheever's well-rounded criticism he finds the following objections to it.

First there is an effort to make a research anatomist out of the freshman. It cannot be done, and it ought not to be done. One of the teachers in one of the high-class schools told him he did not care for a man to learn too much anatomy because he didn't think every freshman was going to be a surgeon. To that the reply was that it is equally important for the medical man to know his anatomy because the surgeon has the opportunity of going in and finding out. But regional anatomy, and even minute anatomy if known by the clinicians will make them better diagnosticians.

"But," said he, "I insist the best way for the student to learn his anatomy is in the third year at the post-mortem table." To that there is no reply.

He was not one of those who believe that the surgical anatomist is always the best surgeon, but he thought the anatomical surgeon is always the best type of operator.

If we stress the anatomical surgeon we are showing only what the ideal type of surgeon should be.

In his experience on examining boards, he had found that the lowest marks all over the country made in anatomy, both the practical and the written examinations, are made by the highest type of student graduating from the highest type of class A schools. Anatomy should be taught by anatomists and not by embryologists or simply scientific research workers.

DR. ARTHUR DEAN BEVAN (Chicago, Ill.) had taught anatomy for about fifteen years. He belonged to the Association of American Anatomists. Gradually, as medical education in this country was reorganized, the chairs of anatomy passed into the hands of embryologists and biologists and men who were devoting their entire time to research in anatomy. Most of these were, of course, excellent teachers, but gradually the old-time gross anatomist who made anatomy the stepping-stone of clinical work passed out.

At the Johns Hopkins University Mall was a great embryologist. Mall's interest in anatomy was in anatomical research and his conception of gross anatomy was to give the student a cadaver and a book and let him work out his own salvation. The anatomy which the student and the medical man need in their clinical work cannot be acquired in this way. The student must be taught the kind of anatomy that he must know in his clinical work and the teaching of anatomy should be carried through the entire medical course.

He had frequently asked medical students of his own, in discussing a problem in which anatomy was very fundamental, "When did you look in an anatomy last?" The answer often was, "I finished anatomy last year or two years ago." Of course, that is the wrong conception. If Langenbeck did any great service—and he did a very great service—he taught Billroth and the men who followed him that surgery was based upon anatomy and physiology and pathology. Billroth carried that conception throughout his teaching, and the Langenbeck and Billroth school continue strong.

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He had in his surgical department always insisted upon carrying these fundamentals through the third and fourth years. He did not know just what position the teacher of surgical anatomy should occupy but he thought probably the best solution was to have applied anatomy taught by the department of anatomy in the first and second years and the department of surgery in the third and fourth. McLeod brings up this same idea very well in his physiology and biochemistry as applied to medicine. One should realize more and more the importance of showing the student the relationship of these fundamentals right from the beginning of their medical studies.

He agreed perfectly with what Doctor Cheever said about research. Laboratory research is not the only research. He said we are all doing research work. Clinical research is quite as important as laboratory research. In some ways, it is the most important research that is done in medicine. Certainly research on a man is no less scientific than research on the guinea-pig.

### EDITORIAL ADDRESS

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## THE THORACIC LIPOMAS\*

By GEORGE J HEUER, M D

OF NEW YORK, N Y

THE subject of intrathoracic tumors has already become so large that it is difficult to deal with it in a short paper. Just as we have, for some years past, found it necessary to devote ourselves to a single form of brain tumor in our papers and discussions, so now it seems desirable to discuss single forms of intrathoracic tumors. In previous papers I have assembled and discussed individual groups of intrathoracic tumors, such as the dermoid cysts, the chondiomas and chondromyxomas, and the hour-glass tumors of the spine which involve the thorax. In the present paper I wish to discuss the group of intrathoracic lipomas.

The incentive for this study is a remarkable case of intrathoracic lipoma referred to me by Dr James Alexander Miller.

The patient, an unmarried young woman, twenty-four years of age, was admitted to the Surgical Service of the New York Hospital, December 5, 1932, complaining of pain in the chest, shortness of breath, choking sensations and palpitation of the heart. Her family history is unimportant. Her past history, in view of the condition she presented, seems remarkably free from illnesses of any sort. Closely questioned, she failed to remember any definite symptoms referable to her chest before the onset of her present illness. This occurred February 11, 1932, with a sharp, stabbing pain in the left chest and back, intensified with each respiratory effort. She developed marked difficulty in breathing and the following day was so ill that she was taken to the Cooper Hospital in Camden, New Jersey. She arrived there in poor condition, ashen in color, and profoundly prostrated. X-rays of the thorax were made which showed a diffuse shadow over the left thorax, and with the possibility in mind that the shadow might be due to fluid, her left thorax was repeatedly tapped but without obtaining fluid. Two weeks later she was transferred to the Jefferson Hospital where a bronchoscopical examination was made. The bronchoscopical examination (according to the patient) showed a narrowing of the left bronchus due to pressure upon it. She returned to the Cooper Hospital where a left pneumothorax was induced. Her chest was again tapped and again without result. She went home and sometime thereafter caught a severe cold which intensified the thoracic pain and dyspnoea. She recovered from this but her general condition gradually became worse. In August, 1932, she had a bout of more severe illness, during which she was in bed with some fever, marked dyspnoea and tachycardia, and severe pain in her chest. In November, 1932, the patient consulted Dr James Alexander Miller, who made a diagnosis of intrathoracic tumor and referred her to me.

On admission the patient proved to be an intelligent, optimistic girl. She did not appear ill, was of good color but evidently had lost some weight. She was slightly dyspnoeic when she talked, and had a periodic hacking cough. Physical examination other than that of her chest was essentially negative. There was no ascites, no oedema of the extremities, and no clubbing of the fingers. The thorax on inspection was mark-

\* Read before the New York Academy of Medicine, April 7, 1933

edly asymmetrical. There was a noticeable bulging of the left half of the thorax anteriorly and some, although less, bulging of the left lateral and posterior thoracic wall. The cardiac impulse could be seen displaced far to the right, and on palpation the apical impulse was in the fourth interspace, nine centimetres to the right of the mid-sternal line. The respiratory movements were restricted over the entire left thorax. On percussion there was dullness to absolute flatness over the entire left thorax, both anteriorly and posteriorly. On auscultation the breath sounds were diminished to absent over the left thorax. The cardiac sounds were rather feeble but normal, the rate rapid, the rhythm normal.

The anteroposterior X-rays of the thorax show a diffuse, ill defined shadow almost completely filling the left thorax. The heart is displaced far to the right, the apex almost reaching the right lateral thoracic wall. The lateral X-ray films show that the shadow does not occupy the upper thorax anteriorly nor the lower thorax posteriorly (Figs 1 and 2). A minute examination of the shadow shows some features of impor-



FIG. 1—Anteroposterior X-ray film of the thorax showing the extent of the shadow cast by the tumor and the displacement of the heart to the right.

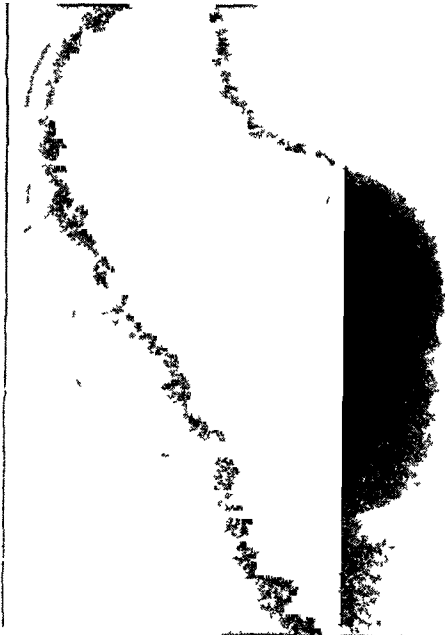


FIG. 2—Lateral X-ray film of the thorax showing the extent of the shadow cast by the tumor.

tance in diagnosis. Compared with the dense central portion of the shadow, the margins of the shadow suggest transparency unlike the shadow cast by a massive collection of fluid and unlike the shadow of other benign and malignant tumors. In a clinic given before our medical students I pointed out that a lipoma would be the most likely tumor to cast a shadow such as this and suggested the diagnosis of intrathoracic lipoma.

It seemed highly desirable to know the nature of this tumor, and I suggested to the patient that she allow me to explore it. She readily consented and the operation was performed December 10, 1932. Under local anaesthesia with novocaine, 8 centimetres of the fifth rib over the lateral thoracic wall were resected. The parietal pleura was stripped from the thoracic wall over a considerable distance. Immediately beneath it there presented the exposed portion of the tumor with its grayish-white capsule. Palpation of the tumor suggested a cystic growth. A large aspirating needle was, therefore, inserted into the tumor and five cubic centimetres of a yellowish, sticky, mucoid fluid drawn into the syringe. This, on microscopical examination, showed large quantities of fat droplets, fat cells and a few epithelioid cells. Doctor Foot, our surgical pathologist, was of the opinion that the tumor was a lipoma. To make the diagnosis more certain,

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an incision five centimetres long was made through the capsule of the tumor. The capsule at the place the incision was made was very thin, beneath it was a layer of tissue one centimetre thick, which grossly resembled fat, and beneath this was a broken-down, greenish-yellow myxomatous material which could be readily removed without bleeding. Material from these parts of the tumor was removed for examination. The exploration was then abandoned, and the wound closed without drainage. There was no upset of any sort during the procedure.

The post-operative convalescence following this operation was uneventful. The wound healed *per primam*. The question arose whether anything further might be attempted toward the removal of the tumor. It was realized that the tumor was of enormous proportions, and that its enucleation *in toto* was quite impossible. But it was thought, in view of the findings at exploration, that a large part of the degenerated myxomatous material might be removed intracapsularly, and I considered the wide exposure of the tumor through the resection of several ribs, the incision and suture of the capsule to the thoracic wall and the removal from within the capsule (in several stages if necessary) of the degenerated central portion of the tumor. I finally suggested this operation to the patient and again she readily agreed.

This operation was to have been performed January 5, 1933, but was not carried into effect. The patient was placed on the operating table and the infiltration of the field of operation with novocaine was begun. Before it was completed the patient complained of feeling queerly, and I attempted to reassure her. She failed to answer and I immediately stopped the infiltration of the operative field. She made some unintelligible noises, evidently attempts at speech, then went into a generalized convulsion. All parts of her body were involved, the pupils were dilated and she became cyanotic. One convulsion succeeded another. An intratracheal catheter was quickly passed and artificial respiration begun. The patient died at the end of a convulsive seizure. The symptoms leading to death were those described as pleural reflex or pleural eclampsia.

I shall not relate in detail the necropsy findings but confine myself to those of greatest interest. On opening the abdomen the most striking feature was the marked downward bulging of the entire left diaphragm and to a lesser degree the right. The liver was pushed downward so that its edge was eight centimetres below the costal margin and the upper portion of the left lobe was flattened and almost concave, due to the pressure from above. There was no free fluid in the abdominal cavity.

On removing the anterior thoracic wall the entire thoracic cavity seemed filled with a large, smooth, rather yellowish, more or less spherical tumor mass. The heart and lungs could not be seen. *In situ* at its widest diameters the tumor measured twenty-five centimetres in its vertical and transverse diameters. The greater part of it lay in the left thorax but posteriorly it filled as well the lower portion of the right thorax. There were few adhesions between it and the thoracic wall except at the site of the previous operation and when these had been divided the tumor easily could be delivered from the thoracic cavity. The tumor, the heart and the lungs were removed *en masse* and together weighed 5.65 kilograms (12½ pounds). (Figs 3 and 4.)

Examination of the relationships to the heart and lungs shows that the tumor arose in the anterior mediastinum. It measures twenty-five by twenty-five by thirteen centimetres in diameter, is fairly firm but suggests fluctuation on palpation. The capsule is smooth, yellowish or grayish-white and varies in thickness. After hardening in formalin the tumor was sectioned, showing an outer capsular layer, varying in thickness and made up of fatty tissue, and a central mass made up of degenerated myxomatous material. (Fig 5.)

The left lung was very small, totally collapsed and atelectatic and completely flattened over the posterior upper margin of the tumor. The right lung was considerably encroached upon but was crepitant throughout. The heart was small and atrophic. The pericardium was thickened and showed a fine fibrinous pericarditis. The posterior surface of the tumor was quite densely adherent to the anterior pericardium.



FIG 3—Photograph of the body at the post mortem after the removal of the sternum and ribs. The entire anterior thorax is filled by the tumor. The heart and lungs cannot be seen. The diaphragm is depressed. The liver is small.

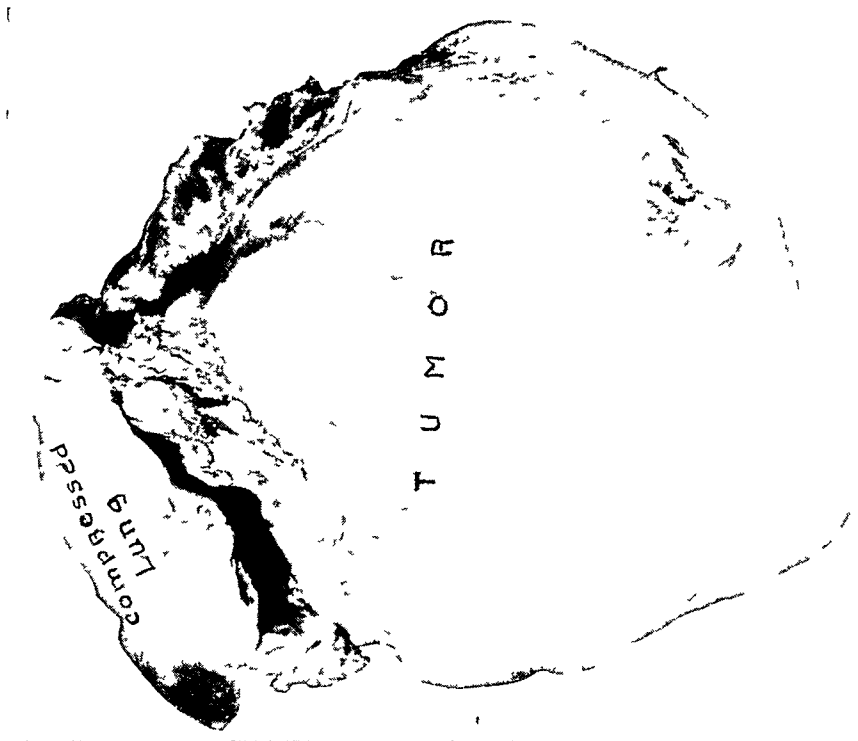


FIG 4—Photograph of tumor after removal from the thorax. The compressed lungs are attached to the specimen.

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With the peculiarity of the patient's death in mind the surface of the parietal pleura under the field of infiltration was carefully examined. No puncture wounds of the pleura could be demonstrated. The brain was removed and examined in detail. Nothing abnormal was found excepting some small air bubbles in the superficial veins over either hemisphere of the cerebrum.

*Comments*—There are a number of features in this case which perhaps are worthy of mention. Considering the size (twelve and a half pounds) which the tumor had attained, it seems remarkable that symptoms referable to it should have been present only ten months before the patient came under our observation. But other similar tumors which will be cited further on, have also reached an enormous size before causing

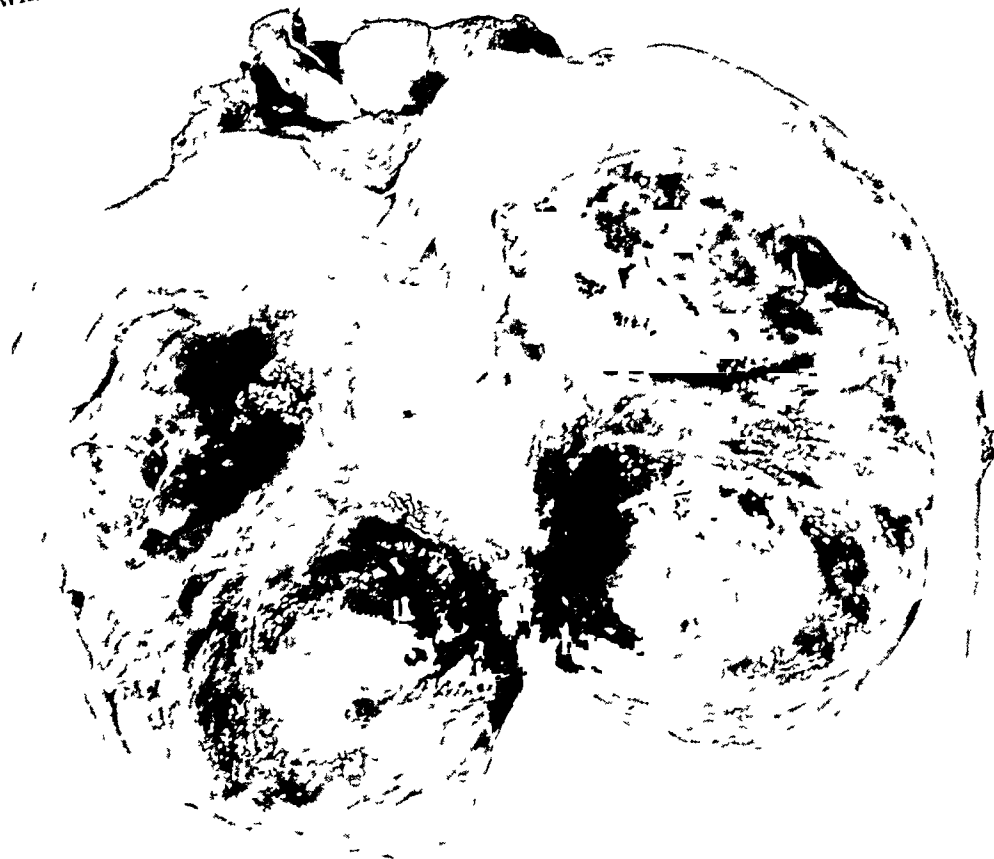


FIG 5—Section of tumor showing outer capsule of fat and central myxomatous material

marked pressure symptoms and it is evident that the intrathoracic organs may endure great compression if the compression is exerted slowly and progressively. The clinical and the X-ray findings both suggested fluid in the chest and justified the repeated aspirations. The diagnosis of tumor having been established, the character of the shadow cast on the X-ray film by the tumor strongly suggested the nature of the growth. The dramatic death of the patient coming on so unexpectedly and so suddenly with major convulsive seizures is an unforgettable experience, and is the first that I have had. The symptoms resembled those described in pleural reflex or pleural eclampsia, but whether the condition was this remains problematical. The patient had been repeatedly tapped before operation without untoward symptoms. She had been operated upon before without symptoms. The autopsy showed that the needles used in infiltration of the thoracic wall with novocaine had not at any point penetrated the pleura. The suggestion has been made that this was a novocaine death. In regard to this it is to be noted that



in the previous operation as much novocaine was used without ill effect, and that an interval of twenty-six days elapsed between operations. It was noted at autopsy that some of the cerebral vessels contained air emboli and the question was raised whether air embolism might not have caused the fatal outcome. In regard to this there was no evidence at autopsy that either a vein or an artery in the thoracic wall was punctured during the infiltration of the tissues. Moreover, the occurrence of air in the cerebral vessels at autopsy is not uncommon. As Meagher suggests, if the skull cap is pulled off after the large vessels at the root of the neck have been divided, the increase in the intracranial space due to the removal of the skull cap will cause air to be sucked up into the cerebral vessels.

*The Literature on Intrathoracic Lipoma*—In the literature from 1783 to the present time, I have found records of twenty-eight cases of thoracic lipoma, exclusive of those reported as lipomas of the pericardium. The first case which I was able to find was reported by Fothergill in 1783, the second by Cruveilhier in 1856. In the forty-four-year period between 1856 and 1900, eleven cases are reported, in the period from 1900 to the present time, fifteen cases are recorded. In twenty-six of the twenty-eight cases the original articles were available to me, in two cases the original articles were not found or were not available. These are the cases of Auvray cited by Garre, and of Chiari cited by Gussenbauer.

In reviewing these cases it becomes apparent that the thoracic lipomas may conveniently be divided into three groups, first, a group in which an intrathoracic tumor is continuous with an extra-thoracic tumor giving rise to a growth with an hour-glass form, second, a group in which a mediastinal tumor extends into the neck, third, a group in which the tumor lies entirely within the thoracic cage. I shall discuss the three groups in the order given.

(1) *The Hour-Glass or Dumb-Bell Tumors*—Of the twenty-eight cases of thoracic lipoma, nine belong to this group. They are characterized by possessing two masses connected by a constricted portion or isthmus. The one mass lies within the thoracic cage, the other lies external to the bony thorax. The constricted portion occupies a perforation in the thoracic wall, usually between the ribs. A study of these nine cases shows that in size the *external tumor* varied from that of a walnut to that of a man's head, the majority being fairly large tumors, and in position presented over the anterior thorax to the right or left of the sternum in five cases, and under the left breast, in the right axilla, over the lateral thoracic wall and over the back below the left scapula, each in one case. The perforation in the thoracic wall occurred in an intercostal space in all but one case and varied in size up to that of the diameter of "an egg." The constricted portion of the tumor corresponded in size with that of the perforation in the thoracic wall. The *intrathoracic portion* of the tumor varied in size, as did the extrathoracic, the largest recorded specimen being about the size of an "infant's head." The patients harboring these tumors varied in age from one to fifty-six years. Three of the patients were male children one year, fifteen months and twenty-two months of age respectively, one was a boy eighteen years old, and four were adults over forty. It is to be noted that in the three children the external tumors were discovered

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when they were six months of age, an indication that the tumors may have been congenital

The symptomatology of the hour-glass lipomas need only briefly be discussed. In all nine cases there was a visible, palpable external tumor. They had been discovered for from three months to three years before the patients had come under the observation of the physician. The subjective complaints as noted in the case histories are rather few and relatively slight. In two cases the condition was symptomless, in four pain was the chief complaint, and in two dyspnoea (in one with cyanosis) was the most noticeable symptom. On physical examination the external tumor is described as soft and fluctuant with a smooth or lobulated surface to which the overlying skin is not attached, and in three cases in addition it is noted that the tumor was fixed to the thoracic wall. The physical findings with reference to the thorax are noted in only four cases, in two they are reported as normal and in two, dullness on percussion in the region of the external tumor and diminution in the breath sounds on auscultation are recorded. X-ray reports are given in two cases, in one the chest was reported as normal, in the other it showed an intrathoracic shadow. Aspiration of the external tumor is recorded in three cases, in each with negative results. A positive diagnosis of the true nature of the condition is recorded in only one case in which the X-ray showed a tumor shadow within the thorax. The external tumor was correctly diagnosed in three cases but an intrathoracic extension of the tumor was apparently missed. In one case the external swelling was diagnosed a cold abscess.

The treatment in all of these hour-glass lipomas was surgical and consisted in the attempt to remove the tumors. In the dissection of the external tumor it was found that the narrowed isthmus of the tumor perforated the thoracic wall, in the second intercostal space in two cases, in the third intercostal space in two, and in the fourth, sixth and seventh intercostal spaces each in one case. In one case the exact intercostal space is not noted. In one case the tumor perforated the sternum. In six cases both the external and internal tumors were removed, in three the external tumor alone was removed. Following operation five cases recovered and were cured, four died and came to autopsy. An analysis of the deaths shows that all resulted from infection presumably due to faulty surgical technic. The deaths occurred in the years 1856, 1875, 1876 and 1889, before aseptic technic had been developed. The three cases in which only the external tumor was removed all died of infection.

The Origin and Development of the Hour-Glass Lipomas—Perhaps the most interesting feature of the hour-glass lipomas and similar tumors is the consideration of their origin and development. The views expressed in the literature are many and varied. I shall omit the earlier discussions of Virchow, Billroth, Cohnheim and others regarding the origin of deep-seated lipomas in general and the later discussions as to whether these tumors are true tumors or the result of the hypertrophy of local collections of fat. Two views developed as to their origin and direction of growth. According to one view they have their origin in the mediastinum or in the subpleural space and

force their way through the intercostal space, according to the other they arise outside the thoracic wall, penetrate the intercostal space, and extend into the mediastinal or subpleural space. Rokitsky assumed that they arose outside the thoracic cavity and penetrated the thoracic wall, and Czerny after a study of his case was of the same opinion. Harms believed that they originated in the musculature outside the thoracic wall and penetrate it, basing his opinion on the mistaken information that lipomas do not occur as intrathoracic tumors only. Gussenbauer on the other hand thought that the tumor in his case originated in the subpleural space and penetrated the thoracic wall externally, basing his belief on the finding that the external portion of the tumor was covered by the endothoracic fascia. Garnier thought that the tumor in his case arose in the anterior mediastinum and, in expanding, extruded through a defect in the sternum. Beyers found it difficult to say whether the tumor in his case originated in the extrapleural or extrapericardial fat or in the loose areolar tissue which fills the anterior mediastinum. He questioned whether it was possible for a soft tumor like a lipoma to penetrate the thoracic wall through an extremely narrow interchondral space occupied by the intercostal muscles and intercostal membrane and strengthened by slips of the triangularis sterni muscles. He believed that possibly the increase in size and vigor of the heart may have assisted in its extrusion, but thought that in its growth the tumor would be more likely to take a direction of lesser resistance into either pleural cavity. Yates and Lyddane also questioned the probability of a tumor, originating internally, penetrating the thoracic wall, but expressed the possibility that the pressure exerted by the heart's action and the lungs during inspiration may be sufficient to force a part of the tumor through a congenitally weak spot in an intercostal space.

Coenen, in 1927, expressed another view which, to me, seems to explain these tumors better than those just mentioned. He conceives of these tumors as congenital, appearing early, before the bony structures of the thorax have fully developed. In the development of the thoracic cage the tumor, playing a passive rôle, is impinged upon and constricted with the formation of an extra- and intrathoracic tumor. A study of the nine cases of hour-glass lipoma shows that three were first discovered in infants six months of age—an indication, certainly, that in these cases the tumor was congenital. With possibly one exception, the intrathoracic portion of the tumor lay in the mediastinum, a favorite site for congenital tumors (dermoid cysts, teratomas, *etc*). Moreover, analogous tumors are found in other parts of the body. In a previous paper on the hour-glass tumors of the spine, I pointed out that the characteristic of these tumors is that they possess an hour-glass shape, the constricted portion of which occupies an intervertebral foramen, the one enlarged portion occupies the spinal canal, while the other enlargement lies in the tissues of the neck, the mediastinum, *etc*, depending upon the level of the growth. These tumors are chiefly the neurinomas, neurofibromas and fibromas, one is a lipoma. In this paper I called attention also to certain fibrolipomas of the spine associated with spina bifida occulta which present similar characteristics,

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to certainly similarly shaped dermoid cysts of the head, to the rather rare upper epigastric herniæ which apparently perforate the xiphoid, and to the persistent thyroglossal ducts which apparently perforate the hyoid bone. In these various conditions somewhat similar factors as regards the growth and shape of the tumors must obtain. It seems doubtful that a soft tumor like a lipoma arising either within or without the thoracic cage would perforate the rigid wall of the thorax rather than grow locally within or without the thorax, or that a fibrolipoma of the spine would force its way through vertebral laminæ rather than grow within the spinal canal or in the muscles of the back. Would it not appear more logical, for example, in the latter case, to assume that the failure of the laminæ to fuse was due to the interposition of a pre-existing fibrolipoma, rather than that a fibrolipoma just happened to occupy an unexplained defect in the spine?

(2) *The Superior Mediastinal Lipomas Presenting at the Root of the Neck*—There are only three cases of this sort reported. The tumors apparently arise in the anterior superior mediastinum and extend upward presenting as visible palpable tumors at the root of the neck, either directly above the manubrium or to one side of the suprasternal notch. In Graham's case the tumor measured nine by five centimetres in diameter, in Beatson's case it was about the size of an "orange", in Lemon's case it was larger than a "quart cup."

The patients harboring these tumors were men of forty-three, forty-five and forty-six years of age. The tumors of the neck had been present for six months, eighteen months and five years before coming under observation. The symptoms varied. In Beatson's case they were inconspicuous or absent, in Graham's case they consisted of pain in the neck, choking spells, dyspnoea, cyanosis and hoarseness, in Lemon's case, when first observed, of mild dyspnoea and occasional hemoptysis but later, before death, of severe dyspnoea, cyanosis and paroxysmal cough. Except for the external tumor the physical examination in Graham's and Beatson's cases failed to show any noteworthy abnormal findings, in Lemon's case it showed mediastinal dullness on the right, diminished excursion and distant breath sounds on the right, and displacement of the heart to the left. The X-ray of the thorax in Graham's case failed to show a mediastinal shadow, in Lemon's case it showed a large, lobulated, mediastinal tumor extending into the right thoracic cavity. Of the three cases Graham's and Beatson's were subjected to operation, and in both the tumor was successfully removed through a "collar" incision with the cure of the patients. Lemon's case, notwithstanding a correct diagnosis, was treated by radiotherapy and died two years later.

(3) *The Intrathoracic Lipomas*—Exclusive of the case I have presented, there are sixteen cases reported in which the tumor lies entirely within the thorax. They are scattered through the literature from 1783 to the present time and are often incompletely reported. Of the sixteen cases, ten and, probably eleven died, according to the case records, of other conditions without a diagnosis of an intrathoracic tumor having been made. One died of

cerebral hæmorrhage, two of pneumonia, one of fracture of the femur, one of empyema, one of Bright's disease and endocarditis, one of pericarditis, and one of angina pectoris. In three the cause of death is not stated. In the majority, certainly, the condition was not suspected until revealed by autopsy. In only five cases, those of Sauerbruch, Leopold, Klemperer, Garre and Rutz, was a positive diagnosis of intrathoracic tumor made before operation or autopsy, but in none a diagnosis of intrathoracic lipoma. In size the tumors greatly varied. Chiari's case presented a tumor the size of a "walnut", Leopold's an enormous tumor largely filling the thorax and weighing seventeen and one-half pounds. Of the eleven cases in which the size of the tumor is stated, three were fairly small (not larger than a "goose egg"), and eight were quite large. That some of them should not have caused more outspoken symptoms during life seems remarkable. The patients presenting these tumors included twelve men and four women who varied in age between twenty-eight and sixty-five years. In only five cases is the duration of symptoms clearly stated, one patient had dyspnoea for twenty years, two for twelve years, one for two years, one for one month. The symptomatology as detailed in the case reports is very much confused. In three cases the tumors were of such size that in all likelihood they failed to provoke symptoms during life. In two cases the symptoms and physical signs were those of an acute pneumonia and quite overshadowed symptoms of tumor if such were present. In one case the symptoms and physical signs were those of empyema, and in one the symptoms were those of angina pectoris. One case presented the symptoms of dyspnoea, cyanosis and fever and died of pericarditis. In one case the symptoms, if any, are not detailed. In only six cases are symptoms and physical signs recorded which may be attributed to the intrathoracic lipoma, and in these the symptoms and physical signs were those common to intrathoracic tumors generally, *i e*, pain in the chest, cough, a varying degree of dyspnoea and cyanosis and cardiac irregularity. In three cases it is evident that the symptoms of an intrathoracic tumor were present for twelve to twenty years although not severe enough to warrant medical attention. Leopold's case before death developed an astonishing degree of dyspnoea and cyanosis in addition to ascites and oedema of the abdominal wall, genitalia and lower extremities. X-ray examinations are definitely recorded in only four cases, those of Sauerbruch, Garre, Klemperer, and Yates, and showed a shadow in the thorax. The cases of Sauerbruch, Klemperer, and Garre were uncomplicated and a diagnosis of intrathoracic tumor was made, that of Yates was complicated by an acute pneumonia which undoubtedly confused the picture. Altogether the intrathoracic lipomas have, thus far, been a confusing group from the standpoint of diagnosis, and, as noted, a diagnosis of tumor was made in only five cases and in none a correct diagnosis of intrathoracic lipoma.

Of the sixteen cases, thirteen died untreated with respect to the tumor, three were subjected to surgical operation (cases of Sauerbruch, Garre and Rutz). In the latter three cases the tumor was completely removed with the recovery and cure of the patients.

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The origin of these intrathoracic lipomas is indeed difficult to determine from the case reports, and having seen the autopsy on the case I have presented, I can understand the difficulties pathologists have had in making accurate statements. In the cases of Conner and Clark, the tumor is stated to have been covered by the diaphragmatic pleura, and in Clark's case the base of the tumor was spread out between the muscle fibres of the diaphragm. These two tumors are, therefore, called diaphragmatic lipomas. They might also be called subpleural lipomas. In the cases of Sauerbiuch and Fitz, the tumors were attached to the pericardium suggesting that they arose from the pericardial fat. Fitz, however, designates his case as one of congenital intra-pleural lipoma. In the case of Chiari the tumor is stated to have lain between the costal pleura and the endothoracic fascia. It is called, therefore, a subpleural lipoma. In the eleven remaining cases the only statements referring to the origin of the tumor lead me to believe that they arose in the mediastinum, in the anterior mediastinum in nine cases and in the posterior mediastinum in two cases. Surveying the entire series of twenty-eight cases it will be seen that the thoracic lipomas thus far reported are, with two possible exceptions, all mediastinal in origin or, at least, occupy the mediastinum, and there is evidence which suggests that many of them are congenital.

SUMMARY—A summary of the preceding pages may be given as follows

(1) A study of the literature shows that twenty-eight cases of lipoma involving the thorax are recorded. To this number I am adding a case, remarkable chiefly because of its size.

(2) The thoracic lipomas as reported may conveniently be described in three groups, a group in which an intra- and extrathoracic tumor is connected by a narrowed isthmus which occupies a perforation in the thoracic wall, a group in which a mediastinal tumor extends upward into the neck, and a group in which the tumor lies entirely within the thorax.

(3) Of the twelve cases falling into the first two groups (presenting external tumors) eleven were subjected to operation, and one died untreated of mediastinal compression symptoms. Of the eleven cases operated upon, seven recovered after the complete removal of the tumor and were cured, and four died. The four deaths resulted from infection and occurred in a period before the development of aseptic surgery.

(4) Of the seventeen cases (including that herein reported) in which the tumor was entirely intrathoracic, in only six was a positive diagnosis of intrathoracic tumor made before operation or necropsy, in only one a positive diagnosis of intrathoracic lipoma (my case, biopsy). In many of the cases the failure to diagnose tumor was in part due to the presence of complicating conditions which confused the clinical picture, in part to the failure of X-ray examinations. Of the seventeen cases, fourteen died untreated, and three were subjected to operation. The three cases subjected to operation recovered after the removal of the tumors, and were cured.

(5) The intrathoracic lipomas have in some instances developed into

tumors of great size The case of Leopold (seventeen and one-half pounds) is the largest intrathoracic tumor I have found recorded It is evident from the case histories that some of them may reach great proportions before giving rise to serious pressure symptoms, and that some have grown very slowly Their origin is somewhat problematical Of twenty cases (exclusive of the hour-glass tumors) in which the tumor was entirely intrathoracic (seventeen), or presented at the root of the neck (three), the tumor apparently had its origin in the mediastinum in seventeen, and in the subpleural space in three Of the nine cases of hour-glass tumor, the intrathoracic part of the tumor occupied the mediastinum in eight, the subpleural space in one There is some evidence that the thoracic lipomas are congenital tumors, in the hour-glass variety, because of the early appearance of some of the recorded cases, the difficulty of otherwise explaining their form and direction of growth, and the analogy with other tumors in the body, in the intrathoracic variety because of the hypoplasia of the lung and heart, especially well illustrated by the cases of Fitz and me, and the evident duration of symptoms

A summary of the cases reported in the literature follows

GROUP I—*Hour-Glass Tumors*

CASE I—CRUVEILHIER, J (Traite d'Anatomie pathol generalis, vol iii, p 315 Balliere et fils, Paris, 1856) There are but few details of this case The author states that a patient presented a fatty tumor over the sternum which was operated upon The surgeon found on surrounding the tumor that it gave off several prolongations at the lateral border of the sternum which penetrated the thoracic wall and connected with an anterior mediastinal tumor The external tumor was removed and the prolongation through the thoracic wall partially delivered by traction on the external tumor The mediastinal tumor was not removed The patient developed a suppurative inflammation in the anterior mediastinum and died

CASE II—CZERNY, J G (Wien Med Wchnschr, vol xxi, p 166, 1875) The patient was a white male, eighteen years of age, and a waiter by occupation who complained of a tumor on his back, pain in the left axilla and dyspnoea He had always been well until three years previous to his appearance when he injured his back Following the injury a tumor appeared on his back which has grown rapidly Physical examination showed a well-developed man who presented below the left scapula a tumor the size of a "man's head" Its surface was smooth, the skin over it not attached The tumor was aspirated but no fluid obtained The pre-operative diagnosis was lipoma At operation the external tumor was surrounded and found to be continuous with a pedicle which perforated the seventh intercostal space through an opening the size of a hen's egg The intrathoracic portion of the tumor was freed with the finger and removed in fragments, the combined fragments representing a tumor the size of a "nut" Following operation the patient developed an infection and died the fourth post-operative day The autopsy showed an oedematous, bloody lung and a purulent pleurisy

CASE III—VOGT, CARL (Dissertation, Berlin, 1876 This case is also referred to in the literature as Kronlein's or Langenbeck's) The patient was an infant, one year old, who was brought to the clinic because of an apparently painless tumor over the right anterior thorax The tumor was first observed six months previously and had grown rapidly On examination the child was slightly undernourished The external tumor was large extending from just below the clavicle to the umbilic and in breadth extending from two finger-breadths to the left of the sternum to the right axilla It measured nine centimetres long, three centimetres in height and 15.5 centimetres in cir-

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cumference The skin over the tumor was freely movable, the tumor itself was soft and slightly lobulated There was dullness on percussion of the thorax about the tumor and faint breath sounds An X-ray was not taken At operation the external tumor was freed and found to narrow to a pedicle which perforated the third intercostal space one centimetre to the right of the sternum The external tumor only was removed and grossly and microscopically was diagnosed a lipoma On the fifth day after operation the patient developed a temperature of  $104^{\circ}$  F and the pulse rose to 200 Extreme dyspnoea appeared and the patient died on the eighth post-operative day The condition was called erysipelas The autopsy showed a large mediastinal lipoma extending from the manubrium to the xiphoid and measuring eleven by ten by 8.5 centimetres in diameter The heart was dislocated to the left and posteriorly There was a purulent pleurisy and pneumonia

CASE IV—PLETTNER, G A L (Inaug Diss, Halle, 1889) The case was that of an elderly white woman who presented a tumor over the left thoracic wall Details regarding the patient are lacking At operation the external tumor narrowed to a

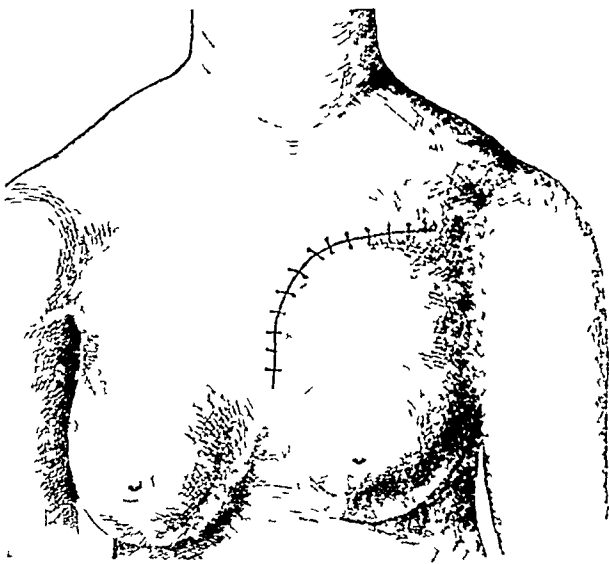


FIG 6—Gussenbauer's case showing external tumor presenting under the left breast and the incision used in its exposure

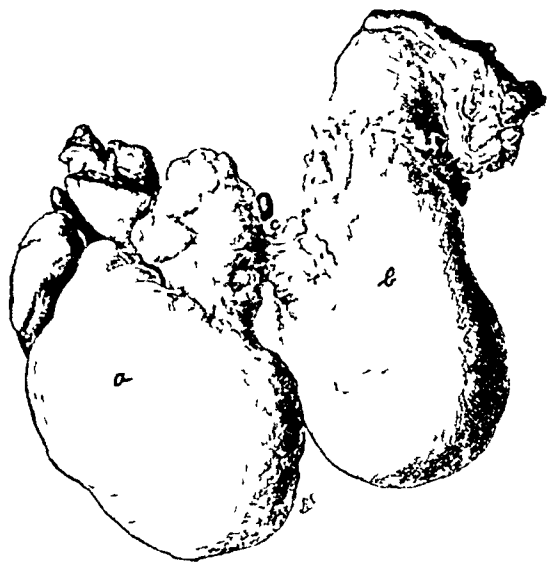


FIG 7—Gussenbauer's case showing the external portion of the tumor (a), the intrathoracic portion of the tumor (b), the isthmus (c)

pedicle which perforated the thoracic wall in the axilla between the fourth and the fifth ribs The external tumor only was removed and was diagnosed a lipoma Following the operation the patient developed an inflammation of the pedicle of the tumor and died At autopsy a "subpleural" lipoma was found continuous with the pedicle of the external tumor There was a septic pleurisy and pericarditis

CASE V—GUSSENBAUER, CARL (Arch f Klin Chir, vol XLIII, p 322, 1892) A white woman, forty-two years of age, complained of cough and swelling under her left breast She was a healthy woman, the mother of four healthy children Examination showed a tumor under the upper part of the left breast which extended out into the axilla The tumor dislocated the breast forward, and was soft and elastic on palpation It was somewhat larger than a "man's fist" On percussion about the tumor there was dullness which extended to the cardiac dullness The heart and lungs appeared normal At operation a curved incision was made around the upper border of the breast (Figs 6, 7 and 8) and the external tumor exposed It was covered by a delicate membrane or capsule which together with the pedicle of the tumor extended through the second intercostal space into the thorax The opening was enlarged by the resection of the third costal cartilage, the intrathoracic tumor freed with the finger and withdrawn from the chest The pleura was not injured The wound was drained After a rather stormy



three-weeks' convalescence characterized by fever and the retention of blood-clots in the wound the patient completely recovered. The tumor weighed 500 grams and was apparently covered by the endothoracic fascia. It was this finding which led Gussenbauer to believe that the tumor originated in the subpleural space and extended outward through the intercostal space.

CASE VI—GARNIER, C, ET GROSJEAN, L (Rev Med de l'est, vol XLV, p 654, 1903) A white man, aged fifty-six, presented himself complaining of pain of three months' duration in and about the sternum. This pain called to his attention a small swelling over the sternum which had been sensitive to pressure. The man otherwise was perfectly well. Excepting for pain there were no symptoms referable to the tumor. Examination showed a tumor the size of an "egg" situated over the xiphoid in the median line. The skin was freely movable over it. The tumor was soft, slightly fluctuant, and painful on palpation. Aspiration of the tumor failed to reveal fluid. The physical examination otherwise was negative. At operation a lobulated tumor was found which extended, by means of a narrow pedicle through the sternum, into the anterior mediastinum. The mediastinal portion of the tumor was delivered through this opening. The patient made an uninterrupted recovery. The tumor was a lipoma.

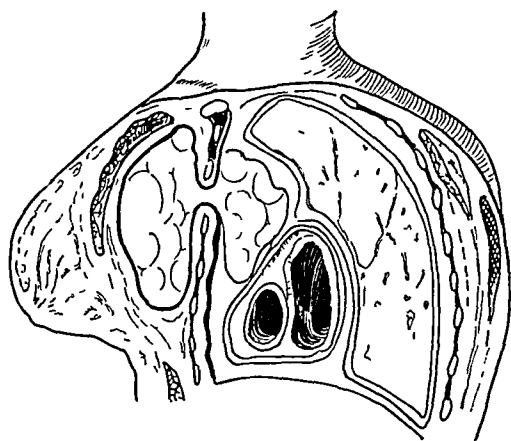


FIG 8—Semi diagrammatic section of thorax showing the relationship of the tumor in Gussenbauer's case

otherwise was negative. The X-ray failed to show a shadow in the chest. The tumor was aspirated with negative results. A diagnosis of subfascial lipoma or sarcoma was made. At operation a lipoma was found lying largely under the major pectoral muscle having a pedicle as large as one's thumb which extended into the mediastinum through an opening in the second intercostal space. The mediastinal portion of the tumor was small and was shelled out without difficulty. The patient made an uninterrupted recovery. The tumor is called a subpleural lipoma.

CASE VIII—BEYERS, C F (Lancet, London, vol 1, p 283, 1923) The patient was a male child, twenty-two months old, who came under observation because of a swelling over the anterior thoracic wall. The tumor had been present for a year and had been growing rapidly. Examination showed a sturdy child, rather pale, but quite healthy, who presented a lobulated, fluctuant tumor, two inches in diameter, to the left of the sternum over the fifth, sixth and seventh costal cartilages. The physical examination otherwise was negative. A diagnosis of cold abscess from a tuberculous rib was made. At operation, an incision parallel to the sixth rib exposed a lipoma possessing a pedicle which penetrated the thoracic wall in the 6th interspace. The sixth and seventh costal cartilages were resected and the mediastinal tumor removed. The tumor on removal presented a typical dumb-bell shape. The patient made a satisfactory recovery.

CASE IX—WALZEL, P (Arch f Klin Chir, vol CLV, p 112, 1932) A white male child, fifteen months of age, came under observation because of a tumor in the right

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axilla His mother had first discovered the tumor six months previously and stated that it had grown rapidly in size At first this tumor was without symptoms Later there developed dyspnoea and slight cyanosis The child was under observation three months before being admitted to the hospital and during this period the tumor and the symptoms both increased Examination showed a tumor in the right axilla the size of a "mandarin" which was not adherent to the skin but was immovably fixed to the thoracic wall The physical examination of the chest is not reported The X-ray showed a large shadow in the right chest and a widening of the right third and fourth intercostal spaces Aspiration of the external tumor did not yield any fluid A biopsy was done upon the external tumor and a diagnosis of lipomyxoma was made At operation the external tumor was freed and as usual in these cases a narrowed pedicle was found which extended through the third intercostal space The external tumor was removed, after which sections of the third to the fifth ribs were resected The intrathoracic portion of the tumor was found to be adherent to the pleura and in its removal the pleura was torn The entire tumor, however, was successfully removed The patient made an uneventful recovery The tumor after removal was of the typical hour-glass shape, the external portion weighing 160 grams, the internal 240 grams The pedicle was the thickness of a "thumb"

### GROUP II—*Anterior Superior Mediastinal Lipomas Presenting at the Root of the Neck*

CASE I—BEATSON, G T (Glasgow Med Jour, vol 11, p 57, 1899) The patient, a white man forty-five years of age, came under observation because of a tumor of the neck which presented above the manubrium sterni The tumor had been present for five years, and during this period had grown steadily in size There are no comments to indicate that the tumor had caused any noteworthy symptoms The physical examination is not recorded The tumor was diagnosed a cyst of the mediastinum At operation (collar incision) the tumor was found to be a lipoma, the size of an "orange," which extended downward into the mediastinum It was freed and delivered The patient recovered Pathologically the tumor was diagnosed a lipoma, although Mr H E Clark thought it might contain elements connected with the thymus gland

CASE II—LEMON, W S (Med Clin N Amer, p 1247, January, 1925) The patient, a minister aged forty-six, came to The Mayo Clinic complaining of dyspnoea, swelling of the neck, paroxysms of coughing and hemoptysis His symptoms were of five years' duration, and a previous diagnosis of enlarged thyroid gland with pressure symptoms had been made Examination showed an obese man with an evident supra-clavicular tumor mass five centimetres in diameter There was no bulging of the thoracic wall and no signs of mediastinal pressure There was mediastinal dullness to the right, diminished excursion of the right thorax and distant breath sounds over the entire right side The X-ray film showed a large, lobulated mediastinal tumor extending into the right thorax Bronchoscopical examination was negative A biopsy (supra-clavicular tumor) showed a simple lipoma The patient was given radiotherapy and discharged His symptoms continued to increase and he developed marked dyspnoea, cyanosis and paroxysms of coughing He died two years after leaving the clinic Autopsy showed a mediastinal lipoma larger than a "quart cup" adherent to the trachea, aorta and right bronchus and extending well into the right thoracic cavity

CASE III—GRAHAM, E A, and WIESE, E R (Arch Surg, vol xvi, p 380, 1928) The patient, a white man forty-three years of age, complained of a swelling of the neck, pain in the neck and chest, choking spells and dyspnoea The swelling of the neck had been present for six months and had increased in size Examination showed a robust man with a diffuse swelling above the sternum, more to the right than to the left of the midline, which apparently extended downward into the superior mediastinum The mass was immovable and not tender There was no substernal dullness There was some hoarseness, and some cyanosis of the finger tips An X-ray film of the chest failed

to show any abnormality excepting a high right diaphragm suggestive of a partial paralysis. Examination of the larynx showed the left vocal cord more active than the right. Under local anæsthesia and through a "collar" incision a tumor measuring nine by five centimetres in diameter and extending four centimetres into the anterior mediastinum was delivered and removed. Pathological examination showed a lipoma. The patient recovered with the prompt disappearance of the hoarseness and dyspnœa.

GROUP III—*The Intrathoracic Lipomas*

CASE I—FOTHERGILL, JOHN (Collected Works, London, 1783, p 509, J Walker Cited by Hare, Hobart, Pathology, Clinical History and Diagnosis of Affections of the Mediastinum, London, 1883) The case is incompletely reported. It concerns a man with symptoms of angina pectoris who died without a diagnosis of intrathoracic tumor having been made. At necropsy a lipoma of the mediastinum was found which was adherent to or involved the pericardium.

CASE II—JURINE, LOUIS (Traite de l'angine de poitrine Appendix, Case IV J J Pachoud, Paris, 1815) A white man, fifty years of age, who complained of faintness and dyspnœa died and at necropsy presented a lipoma which filled the entire anterior mediastinum. The microscopical diagnosis was lipoma.

CASE III—SCHREIBER, A (Deutsch Arch f klin Med, vol XLVII, p 52, 1880) The patient was a white man thirty-eight years of age who had fever, dyspnœa and cyanosis of the face of one month's duration. The patient died and at autopsy showed a lipoma of the mediastinum, bloody fluid in the pericardium and a hæmorrhagic exudate in the pleural cavity. The size of the lipoma is not given. The case is used by the author as a demonstration of the difficulties in differential diagnosis of intrathoracic conditions. The death he attributes to pericarditis. The case is reported by Hare in his monograph.

CASE IV—CLARK, F W (Path Soc Lond, vol XLVIII, p 324, 1887) A white woman sixty-five years of age sustained an intracapsular fracture of the neck of the femur, from the effects of which she died. At necropsy a rounded lobulated tumor, the size of a "goose egg," was found projecting into the right pleural cavity. There were no adhesions between the pleura and the tumor. The base of the growth spread out between the muscle fibres of the diaphragm. The author remarks "With reference to this specimen I would venture to state that there is normally an outgrowth of fat from the diaphragm situate on the right side anteriorly close to the reflection of the pericardial pleura on to the diaphragm. This may, in cases of general obesity, become occasionally so increased in amount as almost to assume the appearance of a fatty tumor, but does not of course constitute a true tumor since it is but part of a general physiological process."

CASE V—CHIARI, O (Cited by Gussenbauer, Arch f klin Chir, vol XLIII, p 322, 1892) A woman aged sixty-two died of Bright's disease and endocarditis, and came to necropsy. An intrathoracic tumor was not suspected during life. At the post-mortem examination a subpleural lipoma the size of a walnut was found lying near the left seventh rib and projecting into the thoracic cavity. The tumor lay between the costal pleura and the endothoracic fascia.

CASE VI—CONNER, L (Proc N Y Path Soc, 1897, p 43) An old woman whose age is not stated died of cerebral hæmorrhage and the intrathoracic lipoma was an unexpected necropsy finding. The tumor was situated to the left and posterior to the cardiac apex, measured four by three centimetres in diameter and was covered by the diaphragmatic pleura. Doctor Conner suggested that it had its origin from the diaphragm and extended into the pleural cavity.

CASE VII—FITZ, REGINALD (Am Jour Med Sci, vol CXXX, p 785, 1905) A fisherman, aged thirty-four, came under observation complaining of pain in the chest, cough with rusty sputum, and dyspnœa. He had been acutely ill for fourteen days and had had a chill ten days before admission. His temperature was 104°, his pulse 145, his

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respirations 50 and his leucocytes 41,200. Physical examination showed dullness over the lower right axilla with absence of respiratory and vocal sounds. A diagnosis of lobar pneumonia was made. The patient subsequently developed signs and symptoms of pericarditis and the pericardial sac was aspirated without obtaining fluid. The patient died on the twenty-first day of his illness. At necropsy the pericardial cavity contained 500 cubic centimetres of opaque yellowish fluid. Attached to the pericardium on the left was a large mass of fat divided into lobules. It was attached to the pericardium, diaphragm, pleura and inferior lobe of the left lung. This lobe was but one-third its normal size, dark red in color and apparently hypoplastic. The final diagnosis was intrapleural lipoma. Its congenital origin in the author's opinion was indicated by the hypoplasia of the left lower lobe.

CASE VIII—BERTOLI, P. (*Gazz. de Osp.*, vol. *xxv*, p. 1108, 1908). A man aged fifty-nine who died of empyema of the right thorax. He failed to present any signs of an intrathoracic tumor. At necropsy a large lobulated lipoma was found in the mediastinum.

CASE IX—GARRE, C. (*Deutsch. med. Wchnschr.*, vol. *xliv*, p. 617, 1918). A white woman, twenty-eight years of age, came to the author complaining of pain in the chest, difficulty in breathing and swallowing and hoarseness. A previous diagnosis of pulmonary tuberculosis had been made and she had taken a "cure" at a sanatorium. Physical examination showed dullness over the right apex, and an X-ray showed an intense spherical shadow filling the right apical region and extending downward to the sixth rib posteriorly. A diagnosis of intrathoracic tumor was made. The patient was subjected to operation and the tumor completely removed through a posterior approach. It lay within the mediastinum and was adherent to the pleura. On removal the tumor measured eight by ten centimetres in diameter, and weighed 270 grams. The pathological diagnosis was fibrolipoma. The patient recovered.

CASE X—AUVRAY, M. (Cited by Garre. *Deutsch. Med. Wchnschr.*, vol. *xliv*, p. 617, 1918). The original reference to this case could not be found. Garre does not give any details of the case. He states simply that Auvray had a case of lipoma of the mediastinum.

CASE XI—LEOPOLD, R. S. (*Arch. Int. Med.*, vol. *xxvi*, p. 274, 1920). A white man, aged thirty-seven and one-half years, complained of persistent cough, pain in the chest, dyspnoea and substernal oppression. His symptoms were of twenty years' duration beginning with cough, followed by thoracic pain and dyspnoea. Eventually he was unable to breathe in the recumbent position and suffered continuously from dyspnoea. Examination showed a man who had lost a great deal of weight and who had continuous air hunger, cyanosis of the head, face and arms, and oedema of the abdomen, genitalia and lower extremities. The anteroposterior X-ray of the thorax showed a dense shadow extending from the third rib to the diaphragm and filling the entire thorax except for a small area on the lower right side. The lateral X-ray showed a similar enormous mass filling the thorax. The patient died with extreme symptoms of mediastinal compression. The necropsy showed a huge lipoma of the anterior mediastinum measuring thirty-one by thirty by fifteen centimetres, and weighing seventeen and a half pounds. It was attached just below the sternal notch. The heart, great vessels and lungs were compressed against the vertebral column and displaced downward. The heart was small and atrophic as in my case. The abdomen was filled with exudate, the viscera congested. The lower extremities were extremely oedematous.

CASE XII—SAUERBRUCH, F. (*Chirurgie d. Brustorgane*, vol. *ii*, p. 376. Julius Springer, Berlin, 1925). A patient whose age and sex are not stated complained of cardiac symptoms and on physical examination was found to have a tumor of the anterior mediastinum. At operation the third costal cartilage was resected and the tumor enucleated without opening the pleura. The pathological diagnosis was mediastinal lipoma. The patient recovered.

CASE XIII—YATES, WALLACE M, and LYDDANE, E STEWART (Amer Jour Med Sci, vol clxxx, p 79, 1930) The patient was a carpenter, aged forty-four, who had suffered from dyspnoea on exertion since an attack of influenza in 1918 Two days before he consulted the authors he became acutely ill with symptoms of pain in his lower left chest, cough and expectoration of mucoid, blood-streaked sputum On admission he was dyspnoeic, had pain in his chest, cough and blood-streaked sputum His temperature was 102°, pulse 120, respirations 28, and leucocytes 15,750 On physical examination there was flatness on percussion over the right lower thorax with diminished breath sounds and crackling inspiratory rales throughout the lungs The X-ray of the chest showed a dense opacity of the lower two-thirds of the right chest and an opacity of the lower portion of the upper lobe The sputum showed the pneumococcus, type 4 A diagnosis of pneumonia was made The patient died on the fourth day after admission At necropsy the right lung was completely consolidated and but one-third the normal size The heart appeared normal Occupying the anterior mediastinum and largely filling the right side of the thorax was a large, yellowish tumor, twenty-eight centimetres long and weighing eight and a half pounds, which on gross and microscopical examination was a pure lipoma

CASE XIV—EWING, JAMES (Neoplastic Diseases, p 199 W B Saunders Co, Philadelphia, 1931) A middle-aged white man who at necropsy presented a mediastinal lipoma encircling nearly all the structures of the thorax and made up of five main lobules each the size of a "goose egg" The tumor arose in the anterior mediastinum and filled one-half of the left pleural cavity

CASE XV—KLEMPERER AND RABIN (Arch Path, vol vi, p 385, 1931 (Fourth case) A white man, forty-one years of age, was admitted to Mount Sinai Hospital September 6, 1919, complaining of pain in the right side of the chest He was dyspnoeic and on physical examination presented the signs of fluid in the right chest X-ray examination showed a large shadow almost completely filling the right side of the thorax which was interpreted as due to a neoplasm He left the hospital to return after a lapse of eleven years (1930) His symptoms had increased and on his second admission he was intensely cyanotic and dyspnoeic and showed an enlargement of the liver and oedema of the lower extremities He died of cardiac failure At necropsy there was noted marked cyanosis of the head and neck and slight clubbing of the fingers and toes The right side of the thorax was filled with a soft tumor mass, larger than a man's head, which was adherent to the parietal pleura of the anterior and lateral walls of the chest In shape it was like a cast of the right pleural cavity It apparently had its origin in front of the right lower lobe, its base rested on the diaphragm, and its upper pole crowded the middle and upper lobes into the dome of the pleura The pericardial sac did not contain any fluid The heart weighed 480 grams Microscopical examination of the tumor showed the typical structure of a lipoma

CASE XVI—RLETZ, A (Zentralb f Chir, vol lxx, p 41, p 2477, 1932) Details of the case are not given The patient was a young man who had a tumor of the posterior mediastinum causing displacement of the heart and disturbance of the cardiac rhythm This was removed through a posterior approach and proved to be a lipoma the size of two fists The patient recovered

ADDENDUM—Since the paper has been written the following two cases have been found in the literature The one case (XVII) belongs with the group of intrathoracic lipomas, the other case (XVIII) belongs to the superior mediastinal lipomas presenting at the root of the neck

CASE XVII—NARR, FREDERICK and WELLS, ARTHUR (Am Jour Cancer, vol lviii, No 4, p 912) The case was that of a man of thirty-three, a laboratory assistant who had fallen and injured the lower left ribs Subsequently the patient developed the symptoms of an intrathoracic tumor His dyspnoea became so marked that operation

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seemed advisable. At operation the intrathoracic tumor was exposed and as much of it as possible was removed. Post-operative X-ray therapy failed to retard the further growth of the tumor and the patient died five years after the initial injury with a tumor which filled the entire left pleural cavity.

At the necropsy a large intrathoracic mass was immediately seen bulging above the removed breast plate, the mass filling the entire left thorax and approximately the anterior half of the right thorax, forcing the diaphragm down and filling the upper left quadrant of the abdomen. It was quite easily shelled out and was found to be completely encapsulated by a thick fibrous capsule over its entire surface, except about the mediastinum. It was closely adherent to the diaphragm. In places the capsule was torn through and soft, light brown mucoid matter flowed from these areas. The tumor showed three types of tissue, a thick fibrous capsule, adipose tissue and myxomatous tissue. The size and weight of the tumor are not given.

CASE XVIII—FITZWILLIAMS, DUNCAN C L (Proc Roy Soc Med, vol VII, Sect Stud Dis Child, p 19, London, 1913-1914) The author describes the case of a child of six who was seen in January at which time there was a tumor found in the neck and chest which was diagnosed a hernia of the lung. A truss was applied, but by September the tumor had grown so that operation was decided upon. The whole mass was removed and proved to be lipoma with little fibrous tissue. The portion in the neck communicated by means of a narrow isthmus passing down behind the subclavian artery with a much larger portion which lay within the thorax outside the parietal pleura. The tumor was soft, coughing impelled the intrathoracic portion into the neck. The tumor was removed as a whole, and it measured four and three-quarter inches long and about four inches high. The result is not definitely stated but it is presumed that the patient recovered.

# THE TREATMENT OF INTERCOSTAL NEURALGIA OF THE ABDOMINAL WALL

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IRRITATION of any one or more of the seven lower intercostal and first lumbar nerves is a frequent cause of pain and tenderness in the anterior abdominal wall and is commonly mistaken for any one or more of the various intra-abdominal lesions which have pain and tenderness as their outstanding symptoms

In a series of papers,<sup>1-7</sup> one of us has described how neuralgic pain and tenderness of the anterior abdominal wall may simulate acute or chronic appendicitis, biliary or renal disease, gastric or intestinal lesions, inflammation of the uterine adnexa, peritonitis and various other lesions. In these earlier papers the methods of differentiating between parietal and intra-abdominal tenderness were given in great detail. Briefly, parietal tenderness is always found to persist on vigorous palpation made while the patient balloons out his abdomen and voluntarily holds his abdominal muscles so tense that the examiner's fingers cannot possibly come in contact with the abdominal viscera. In about 95 per cent of cases of parietal tenderness hypersensitiveness is also easily demonstrated by pinching a liberal fold of abdominal skin and fat.

When these simple tests are applied in every instance of abdominal pain or tenderness it is found that the symptoms are parietal in location and not visceral in origin in over 50 per cent of the patients.

Intercostal neuralgia of the abdominal wall is due to a great variety of causes and may occur in chronic, acute, remittent or relapsing form. Chronic neuralgia is due most commonly to excessive lumbar lordosis, scoliosis or spinal arthritis.

Exaggerated lumbar lordosis is the most frequent direct cause of chronic neuralgia as well as the common predisposing cause of acute, recurrent and remittent neuralgia of the abdominal wall at all ages but particularly so prior to the age of thirty-five years. Some of our views on lordosis are set forth in a paper on "Chronic Strain of the Lumbar Spine and Sacro-iliac Joints"<sup>8</sup>

Normally there is a moderate degree of lordosis in the lumbar spine. With a patient standing with his heels four inches from the wall and with his pelvis, shoulders and head touching the wall, the normal forward curve barely permits insertion of the examiner's flat fingers between the lumbar spine and the wall. In extreme lordosis there is sufficient space to accommodate the examiner's fist. Only a slight accentuation of the forward lumbar curve may result in sufficient pressure on the nerves at the intervertebral foramina to cause neuralgic pain and tenderness of the abdominal wall.

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Parietal neuralgia, however, is usually encountered in the more severe grades of lordosis and the latter are frequently associated with round shoulders. Excessive lumbar lordosis is found in the asthenic, visceroptotic type of individual and is but one of the many abnormalities found in this form of bad body mechanics. The treatment of chronic neuralgia is directed toward correction of the bad body mechanics by the special exercises developed by Goldthwait and his colleagues and described by Thomas<sup>9</sup> and by Cochrane<sup>10</sup>. Primarily the exercises are directed toward strengthening the abdominal and buttock muscles and the individual must be taught to utilize these muscles in maintaining proper posture until the latter becomes habitual. In badly undernourished individuals active exercises may have to be held in abeyance until the patient gains weight and strength by forced feeding, but help meanwhile may be obtained by recumbency in positions favorable for correcting deformity and by wearing a suitable brace (Cochrane, chapter three). A gain of twenty-five pounds in weight in itself may cause disappearance of neuralgic symptoms in the undernourished, probably due to improved tone of muscles and consequent lessening strain on the spine and its ligaments.

In addition to overcoming the excess lordosis and the neuralgic abdominal pain, the exercises increase the chest capacity and raise ptosed abdominal viscera as we have described elsewhere<sup>11 13</sup>. Our patients with abdominal neuralgia are mainly adults with bad body mechanics. We are hoping that the views expressed in the White House Conference report on Body Mechanics<sup>14</sup> will result in prevention or correction of bad body mechanics in childhood with a marked amelioration of the hollow back, round shoulders, sunken chest, visceroptosis, abdominal neuralgia and chronic invalidism in adults.

When scoliosis causes neuralgia the nerves involved usually come off on the side of the concavity. In frank cases of compensating S-curve it is not uncommon to find neuralgic symptoms in one lower quadrant of the abdomen and in the opposite upper quadrant of the chest. Shortening of one leg, generally of moderate degree, is a frequent finding and should be sought for in every case of scoliosis and if found should be corrected by elevation of the heel of the shoe on the short side. In our opinion equalizing the length of the two lower extremities is an essential preliminary to overcoming the scoliosis and in itself frequently abolishes pain of many months' or years' duration. With a C-curve of the spine a low shoulder will be found on the same side as the short leg but with an S-curve the low shoulder is usually found on the opposite side. When the spine is supple simple heel elevation in itself in S-scoliosis may completely equalize the height of the shoulders, correct the milder grades of scoliosis, and overcome the parietal pain and tenderness. In C-scoliosis unilateral bending exercises are necessary to bring the shoulders to the same level.

Scoliosis is frequently associated with excessive lumbar lordosis and the exercises employed for the latter commonly correct postural scoliosis. In transitional scoliosis, however, the lordosis exercises need to be supplemented by special bending and rotating or even hanging exercises. Scoliosis with



structural changes calls for orthopædic treatment which is beyond the scope of this paper to describe. In many of the most extreme cases of scoliosis there are commonly no neuralgic symptoms due probably to long-standing adjustment of the vertebræ to the changed conditions and consequent lack of inflammatory irritation in the region of the intervertebral foramina. This tendency to ultimate spontaneous disappearance of neuralgic pain and tenderness of the abdominal wall is frequently noted also in patients with exaggerated lumbar lordosis or with spinal arthritis.

Parietal pain with spontaneous recovery is the most plausible explanation for those cases in which the original abdominal pain and tenderness persist for a year or longer following intra-abdominal operations and then disappear. This situation is well illustrated in the follow-up investigation of the results of gall-bladder operations by Stanton<sup>15</sup> who found in one group in which the pathological changes in the gall-bladder were indefinite that "all reported cured or satisfactorily improved at the time of the last end-result note but in none of these cases can I demonstrate a cause and effect relationship between the operation and the final result. Either final recovery took place months or years after the operation, or there have been intervening recurrent attacks of symptoms indistinguishable from those for which the patient was operated on."

In the later years of life lumbar lordosis and scoliosis are relatively less frequent causes and spinal arthritis a more common cause of intercostal neuralgia of the abdominal wall.

Any form of spinal arthritis may cause neuralgia. Pressure on the intercostal nerve roots results from the extradural inflammatory exudate as described by Nathan<sup>16</sup>. The neuralgic abdominal pain in somewhat over half of these cases is greatly benefited or abolished by a few mild applications of X-rays to that portion of the spine from which the affected nerves take their origin. About 15 to 20 per cent of an erythema skin dose is employed four to six times at intervals of five to seven days. Some benefit is obtained by diathermia and massage applied to the same region. In acute arthritis rest of the spine is indicated whereas in chronic arthritis, particularly if body mechanics is bad, postural exercises are usually indicated. Treatment should be directed toward cure of the underlying arthritis as well as relief from the pain. We believe that any demonstrable toxic foci should be eliminated if possible, first, because they may be the cause of the arthritis and, second, because they impair the general health and resistance of the patient.

Because of the striking cause and effect relationship between acute toxæmia and acute neuralgia we fully expected to find a similar relationship between chronic toxæmia and chronic neuralgia but our experience has proven otherwise. The elimination of various forms of chronic toxic foci has only rarely had any direct effect in lessening the pain and tenderness of chronic neuralgia.

Franke, a writer on neuralgia of the abdominal wall whom we have quoted in another paper,<sup>7</sup> sends us an urgent personal request to instruct the medical

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profession of America that chronic influenza is the usual cause of chronic neuralgia. We have complied with his request but we are not in accord with his opinion.

We have been amazed at the relative infrequency with which we have encountered syphilis as a cause of either chronic or acute neuralgia.

In the occasional neuralgias due to tuberculosis of the spine (Pott's disease), typhoid spine, tumor of the spinal cord or any form of spinal meningitis, treatment is directed toward the causative lesion. We have seen severe neuralgia disappear within an hour following blood transfusion in severe anæmias of the pernicious and secondary types. Many patients with mild chronic neuralgia seek our advice on the assumption they have appendicitis, cancer or some other intra-abdominal lesion but when reassured in those directions they elect to retain their mild pain and tenderness rather than take the time and trouble to eliminate them.

Patients with severe chronic neuralgia require some form of salicylates or other anti-neuralgic drugs to lessen their pains pending improvement in the underlying spinal condition. Fortunately, the vicious pain sometimes encountered in acute neuralgia is exceedingly rare in chronic neuralgia and we do not resort to morphine except when malignant disease which does not yield to irradiation presses upon or actually invades the nerves usually at or near the spine. Chronic neuralgia of the abdominal wall is a common cause of the morphine habit.

We have had some curious experiences with anæsthetization of intercostal and first lumbar nerves by injections of novocaine in chronic neuralgia. We aim to deposit about 3 cubic centimetres of 2 per cent solution in the immediate vicinity of each affected nerve and we then need to wait five to ten minutes for the anæsthetic to take effect. Normally, the effect of the anæsthetic would be expected to pass off in an hour but not infrequently pain and tenderness which have been present for months or years disappear for one to many weeks or months even when the novocaine has been deposited around and not into the nerve. This effect never extends to non-anæsthetized hypersensitive nerves. Before resorting to section or alcohol injections of nerves we always try the effect of novocaine and if the latter gives prolonged relief we withhold the more drastic measures. When, as rarely happens, neuralgia affects only one intercostal or first lumbar nerve we commonly resort promptly to alcohol injection or to section of the nerve with avulsion of its distal end if novocaine gives only transient relief. We have not employed paravertebral alcohol injections. We do not employ section nor alcohol injections for more than three nerves. When, as commonly occurs, more nerves are involved we rely on other methods of treatment. Section or alcohol injection of the three most painful nerves in a more extensive area of chronic neuralgia is so often followed by increased pain and tenderness in adjacent nerves that we have practically abandoned employing them under these circumstances.

The majority of the chronic neuralgia patients, who habitually have their

most severe pain during the night or when they first awaken in the morning, are benefited by shifting to a different bed usually with firmer springs and mattress

The more widespread the pain and tenderness of chronic neuralgia, the less likely are they to be benefited by any of the measures we have discussed except when they are due to spinal arthritis. We occasionally see a patient with hypersensitiveness of every spinal nerve on one side of the body and none on the opposite side. Their spontaneous pain is usually much more limited in extent. Possibly their trouble may be due to a toxæmia or other affection of a sensory tract in the spinal cord. We have not had much success in treating them. In one girl in particular, twenty-three years of age, we had numerous specialists examine the patient and we tried out every form of treatment suggested for eighteen months without improvement. Treatment was then stopped and after a few months spontaneous recovery occurred.

Another puzzling group of patients, often fat individuals, are those who are hypersensitive everywhere on the surface of the body indicating involvement of all the spinal and cranial sensory nerves although their spontaneous pain is much more limited. Some of these cases may belong to the type described as having a low threshold for pain whatever that may mean but the future is likely to disclose a better explanation for their universal tenderness. Some of them probably have an endocrine disturbance. In a few cases where the basal metabolic rate was elevated or depressed we have had success by treatment directed toward the thyroid dysfunction.

Evidence of ovarian or uterine endocrine disturbance is seen in many women with chronic neuralgia who have exacerbations before or during their menstrual periods. Their neuralgic pains and tenderness of the abdomen and thighs are often associated with similar symptoms in the breasts and scalp.

Premenstrual breast pains are commonly ascribed to congestion of the breast but in our experience neuralgia is the main factor. In the first place the pain and tenderness are not confined to the breasts but extend wide of them, often affecting the shoulder, neck, scalp and scapular region as well as the lower abdomen, buttocks and thighs. Pains in the breasts not infrequently persist in mild form between the exacerbations. Patients who have had a simple or radical amputation of the breast frequently have nearly or quite as much pain on the operated as on the non-operated side, and the nerve trunks from the upper dorsal spine to the breast regions are tender. These pains cease during the first day of the menstrual flow. Cutler<sup>17</sup> has been successful in subduing premenstrual breast pains by the oral administration of ovarian residue. We have not had much experience with this remedy but our results have not been very brilliant. It is quite possible that some of the newer extracts to modify ovarian and uterine function may relieve premenstrual and menstrual neuralgia. Other endocrine preparations may prove helpful but as yet the whole subject of endocrinology is too vague for us to evaluate their importance in neuralgia.

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In our experience, both premenstrual and menstrual pains in the absence of pelvic organic disease occur chiefly in the viscerosomatic type of women and respond best to corrective posture exercises and, when a short leg is present, to elevation of the heel. Thomas<sup>18</sup> has found that of the Smith College students having dysmenorrhœa, but without local examination to determine its possible cause, the pains are abolished in 85 per cent within three to four months after beginning vigorous posture exercises. In women approaching the menopause with severe exacerbations of neuralgic pain either before or during menstruation, irradiation of the ovaries may be considered as an effective means of preventing the neuralgic flare-ups.

Patients having acute, recurrent or relapsing attacks of intercostal neuralgia simulating various acute recurrent or relapsing intra-abdominal lesions almost invariably have as a predisposing cause one of the three spinal lesions commonly found in chronic neuralgia and have as an exciting cause an acute toxæmia from any cause, a spinal trauma, or menstrual disturbance. The predisposing spinal lesion often is adequate to cause a low-grade neuralgia giving mild abdominal tenderness only preceding an acute attack. The superadded acute toxæmia, spinal trauma or menstrual upset increases the nerve irritation to the point of producing acute pain and tenderness. Acute and recurrent attacks often precede the onset of chronic neuralgia. Acute exacerbations of the latter may then result from any of the causes which excite acute neuralgia.

Treatment of the acute attack of neuralgia consists in treating the underlying exciting cause. We have discussed premenstrual and menstrual forms of neuralgia.

Acute neuralgia of the abdominal wall may result from a variety of traumatic injuries in which the spine is jarred or twisted, or some part of it is fractured. We have discussed the traumatic form of diffuse neuralgia at considerable length in a paper on Railway Spine.<sup>19</sup> Localized neuralgia involving one or two nerves may follow fracture of spinous processes by direct violence or fracture of one or two ribs. Traumatic neuralgia is the major factor in the spine injuries which form a big bone of contention in industrial and public liability compensation cases. The special tests for neuralgia in these cases would relieve the great majority of compensation claimants of the stigma of malingering. If traumatic neuralgia is severe the patient should be kept at rest in bed for two weeks or longer. Pillows may be arranged to begin correction of scoliosis or excess lumbar lordosis, and spinal irradiation should be employed in the cases of spinal arthritis. When the more acute symptoms subside, treatment is directed toward the underlying predisposing spinal cause by active exercises rather than by body casts or braces. Unrecognized parietal neuralgia is the usual cause of the localized or diffuse abdominal pain and tenderness following accidents for which patients are kept under observation for "possible internal injuries" which do not materialize. A relatively slight twist or jolt of the spine may result in severe and persistent neuralgia in patients having an antecedent chronic spinal

arthritis, scoliosis or excessive lumbar lordosis. Often the neuralgic symptoms do not appear until forty-eight hours after the accident. In these cases we believe the trauma aggravated the chronic inflammation with resulting soft tissue inflammatory exudate causing pressure on the intercostal nerve roots or nerves within the spinal canal or intervertebral foramina.

Acute neuralgia due to acute toxæmia occurs commonly on the second or third day of an acute follicular tonsillitis and only after one or often two weeks of the upper respiratory tract infection known as a common cold. Patients with severe follicular tonsillitis often deny having a sore throat hence examination is needed to reveal it and its associated tender, slightly enlarged lymph-nodes. The toxic neuralgia of a common cold may not manifest itself until a day or two after the patient believes his cold has "broken up" hence he does not volunteer information about having a recent cold and needs to be questioned thereon. Any acute toxæmia capable of producing fever may cause acute neuralgia. The underlying toxæmia causes fever, pulse hurry, and leucocytosis and when to these are added at the onset of neuralgia vomiting and acute pain and tenderness—the latter two affecting any one part or all of the abdomen—the analogy to diverse acute intra-abdominal lesions becomes apparent. In these acute cases the most important consideration is correct diagnosis. The parietal location of the acute neuralgic tenderness is readily recognized by pinching the skin and fat and by palpation over voluntarily tensed abdominal muscles, but its parietal location is easily mistaken for intra-abdominal tenderness with resulting diagnostic errors if these simple tests are not applied. The finding of acute parietal neuralgia, however, does not preclude the possibility of a coexistent acute intra-abdominal lesion. When the latter cannot be definitely excluded otherwise we abolish the parietal pain and tenderness by anæsthetizing the trunks of the affected nerves with injections of 2 per cent novocaine. The intercostal nerve lies definitely below and not as is commonly believed in the subcostal groove of the superjacent rib (Fig 1). In the early part of their course after emergence from the intervertebral foramina the intercostal nerves lie in such close relation to the pleura or peritoneum that injections are attended by the danger of the needle penetrating the underlying cavity with possible damage to viscera and failure to anæsthetize the nerve. This region should be especially avoided when an alcohol injection is employed to destroy a nerve. Between the anterior and posterior axillary lines the intercostal nerves lie superficial to the internal intercostal muscle in the chest or to the transversus muscle in the abdomen (Fig 2), and with care can be anæsthetized or alcoholized without danger to the underlying structures. Injections of novocaine and of alcohol are made slightly anterior to the posterior axillary line for the intercostal nerves. The depth of the external intercostal muscle is best ascertained in fat patients and for the eleventh intercostal nerve by deliberately aiming the needle to hit the superjacent rib then depressing the point to miss the rib and inserting it about one-half inch deeper. The subcostal or twelfth intercostal is injected by striking the needle against the twelfth rib.

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near its free end, then depressing the point and inserting it through the external and internal oblique to deposit the novocaine superficial to the transversalis. Exceptionally, by accident, the needle may strike the nerve in which event the patient experiences a stab of pain in its terminal distribution and only a few drops of novocaine are required to produce instant anæsthesia. Ordinarily no effort is made to strike the nerve by repeated probing as 3 cubic centimetres of 2 per cent novocaine deposited near the nerve is adequate to cause anæsthesia in about five to ten minutes. Inasmuch as the insertion through the hypersensitive tissues of a blunt needle of large calibre is very painful a very fine needle is employed to produce a small skin wheal and then a very sharp pointed needle of slightly larger calibre is inserted through the wheal and novocaine may be injected through it on its

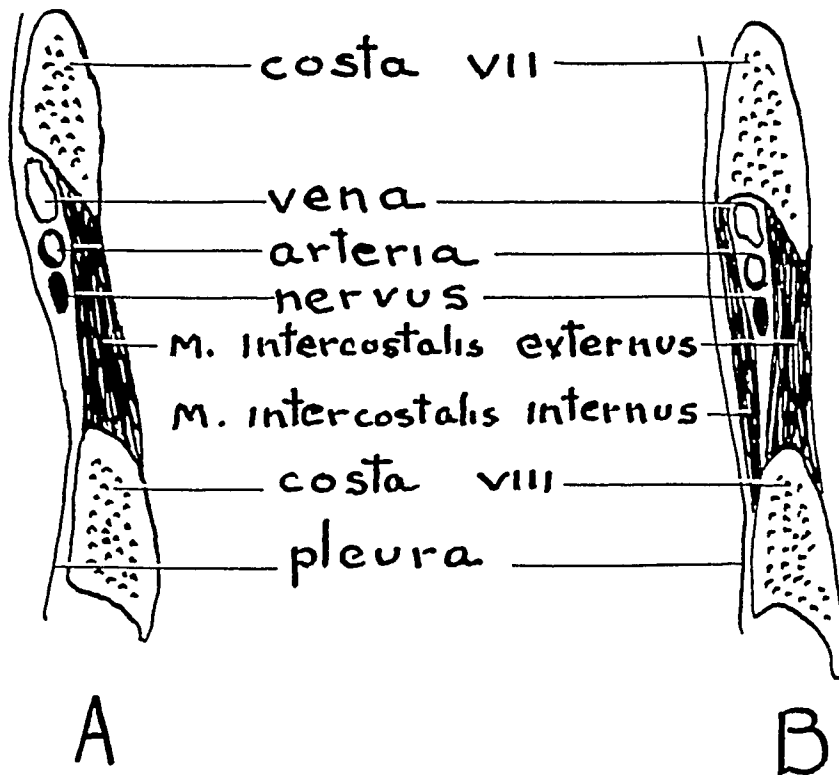


FIG 1—Relations of the intercostal nerve near the neck of the rib in A and slightly anterior to the posterior axillary line in B (Courtesy of Professor Oscar V. Britson)

way into the deeper tissues. When the lowermost abdomen is involved the ilioinguinal and the iliohypogastric nerves are both reached by one injection at a point (in adults) one inch away from the anterior superior iliac spine on a line toward the umbilicus. After inserting the needle through the skin the patient is instructed to hold the abdominal muscles tensed so that the surgeon can recognize more readily the slight jolt as the point of the needle passes through the aponeurosis of the external oblique. Three cubic centimetres of the novocaine solution is deposited between the external oblique and internal oblique.

The parietal tenderness must be abolished as shown by its absence on pinching and on vigorous palpation over tensed muscles before proceeding to examine for real subparietal tenderness. The latter is recognized by tender-

ness which is readily demonstrable by palpation over relaxed muscles and completely disappears on tensing the abdominal muscles. Subparietal tenderness is often due to chronic strain of the lumbar spine and the iliac fossa aspect of the sacroiliac joints and the tenderness will then be confined to them.<sup>8</sup> Subparietal tenderness elsewhere is due to a visceral lesion or peritonitis.

Acute localized or diffuse neuralgia of the abdomen is frequently caused by the toxæmia of acute infections of the uterine tubes. Other intra-abdominal lesions cause a toxic neuralgia only very rarely. Except for acute pelvic infections it is comparatively rare for an acute attack of parietal neuralgia to coexist with any acute intra-abdominal lesion. The most com-

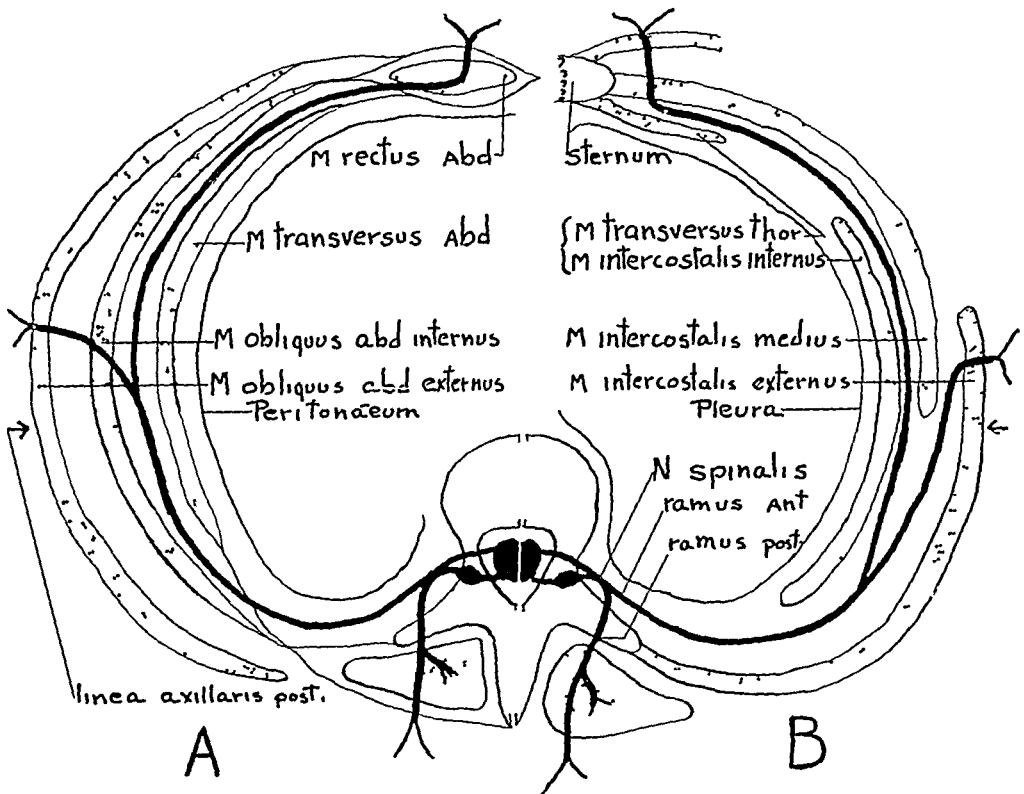


FIG 2—The intercostal nerve in relation to the structures of the abdomen in A and of the chest in B (Courtesy of Professor Oscar V. Batson)

mon associated acute lesion and yet a very infrequent one is acute appendicitis. That parietal neuralgia is not caused either directly or indirectly by appendicitis is proved by the persistence of the neuralgia for a few days following removal of an acutely inflamed or gangrenous appendix during the early stage in which the disease process is entirely confined to the appendix. In the absence of or with the induced disappearance of neuralgic pain and tenderness we have found the most reliable single sign of acute appendicitis to consist of tenderness which is present in the lower right quadrant when the abdominal muscles are relaxed and which is absent when they are tensed so that the examiner's fingers cannot touch the sensitive appendix. When

## INTERCOSTAL NEURALGIA ABDOMINAL WALL

this sign is negative and tenderness is absent on rectal examination we do not hesitate to refrain from appendectomy when fever, tachycardia, leucocytosis as high as twenty or thirty thousand, vomiting and abdominal pain and tenderness are present even though we are unable to find a local focus of acute infection

Treatment depends upon whether or not an acute intra-abdominal lesion coexists with the acute parietal neuralgia. An acute pelvic infection calls for non-operative treatment whereas the exceptional other acute visceral lesions usually require operation. The toxic neuralgia itself calls for treatment appropriate to the underlying causative lesion. An abscess or cellulitis requires incision and drainage. We frequently use an intravenous injection of 20 cubic centimetres of Pregl's iodine for acute follicular tonsillitis which is usually due to a streptococcus infection. The ordinary cold is commonly in the terminal stage before neuralgia appears and as a rule does not require very active treatment. Basilar pleuropneumonia is a frequent source of acute neuralgia of the abdominal parietes and needs to be treated along the usual lines. In toxic neuralgias from any cause but particularly those in which the underlying infection cannot be determined eliminative treatment is indicated. Acute toxic neuralgia usually persists for only a few days and disappears rapidly after subsidence of the toxæmia.

Often the neuralgic pain is too mild to require special medication. Somewhat severer pain is relieved by anti-neuralgic drugs, by the local application of heat and by infra-red light treatment. Exceptionally the pain of neuralgia may be as severe as that seen in perforation or strangulation of a viscus<sup>20</sup> and must then be controlled temporarily if localized by novocaine injections of the affected nerves or if diffuse by heavy doses of morphine.

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# TRANSACTIONS AMERICAN SURGICAL ASSOCIATION

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## WRINKLES AND RECIPES IN INTESTINAL SURGERY

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THIS title may seem simple, but to write on both *why* and *how* would entail too much discussion of the principles of surgery of the intestine. I am writing, here, not for those filled with principles, or the why, but for those still interested in technic, or the how. After many years of surgical work, I believe that the essential principles of surgery are known and followed by most surgeons, but there is wide variation in the acceptance of risks, and in evaluating the probable benefit of operations in the presence of complications of serious import.

In order to evaluate probable immediate and late results of proposed surgical operations involving the intestines in the presence of complications which require immediate appraisal and judgment, an incision permitting of abdominal exploration would at least avert many serious operations, and would lower the operative mortality. However, when the abdomen is distended and obstruction is present, a large incision would be dangerous. In the presence of acute, right-sided abdominal distress and rigidity exploration may disclose a normal appendix, but there may be a generalized distribution of lymph and free fluid. Such a right-sided inflammation, in the presence of a normal appendix, should cause the experienced surgeon to suspect and search for a perforated peptic ulcer. If such a condition is present the escaped content flows around the hepatic flexure past the appendix, and never over the top of the transverse colon and omentum. If an acute ulcer is present, and the gall-bladder and appendix are also diseased, the two latter organs may be removed later. If cancer of the colon and cancer of the liver both are present, external colostomy should be avoided, if possible, the colon should be short-circuited around the tumor, or the tumor removed. Cancer of the liver is slow of growth, but gives rise to new tumors as long as the original growth is present. Death eventually will be caused by cancer of the liver, but life can be prolonged by preventing intestinal obstruction, and patients live from one to two years after developing symptoms, if the original growth is not removable, Röntgen therapy can be employed to check its activity.

As surgeons of wide experience observe the work of their confreres they base their impressions on the results secured, and on the ensemble of the little things, as well as the major things. Most of these little things are the accumulation of years of practical experience in the overcoming or avoiding of incident troubles. Some of the impressions are gained by observation of

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sins of commission or omission of major importance, sometimes causing death, and others by observation of deficiencies of less importance but which cause delayed recovery or less complete success in results of operation

The death of one of the great surgical leaders, Dr George H Monks, of Boston, which occurred early this year, led me to think of some observations he made on a visit to St Mary's Hospital thirty years ago. I was operating on a fleshy patient with a tumor of the descending colon and a short mesentery. The operation was being carried on with considerable difficulty. Doctor Monks observed to me that inasmuch as the colon had developed on the left side of the abdomen, and the cæcum had travelled three-quarters of the way around the abdomen, enclosing the mesentery of the small intestine, all of its blood supply and innervation was contained in its inner leaf. If one looked at the lateral parietal peritoneum, he said, the juncture where the outer leaf united with the parietal peritoneum showed by a fine white line, and if this line were used as the point of division with the knife, the colon would swing out of the incision on to the abdominal wall without injury to any vital structure. I have often made use of this procedure in surgery of the large bowel. To further illustrate the point one year ago a married woman, thirty-four years of age, had undergone an operation at her home, for the relief of pelvic abscess, with adhesions to the sigmoid. In the course of the operation several perforations of the sigmoid had occurred, and the surgeon had removed several inches of it. He then had found it impossible to close the gap between the rectosigmoid and the proximal end of the sigmoid by as much as four inches. Therefore he closed both ends of the bowel and made a permanent colonic stoma in the upper part of the descending colon. The patient came to the clinic in considerable mental distress. The surgeon who undertook the repair was able, by incising this white line of the descending colon, below the stoma, to mobilize the bowel sufficiently to reattach it to the rectosigmoid. The condition was completely relieved.

At the time of Doctor Monks' visit, he spoke of the advantage at times of knowing which was the "up" and which was the "down" of any loop of small intestine without making greater exposure than necessary, or effecting partial evisceration. Such knowledge was particularly valuable, he said, when the bowel was distended with gas, and when a small incision would suffice for anastomosis or drainage by a tube. The point was that the mesentery of the small intestine is folded together at its attachment over the spinal column like the blades of a fan, and if the intestine were lightly held by one hand, and the thumb and finger of the other hand slipped down on each side of the mesentery to its attachment, without it being necessary to rotate the finger or thumb before the base was reached, then the part that was up was proximal, on the other hand, if the mesentery turned, the thumb and finger also would have to turn, and the end that was down was proximal. To find this out requires only a second of time, and a short incision.

In anastomosis of the small intestine, a surgeon may be able to employ his favorite procedure, however, there are occasions when there is but little

choice To know all methods is important, for any one of them may be best and safest in a given case

Relief of obstruction of the upper part of the small intestine is attended by very high mortality, because operation is usually performed a day too late A colon distended because of obstruction is most dangerous when seen late, and temporary cecostomy or colostomy must precede radical surgery, and must be performed with almost no manipulation of the colon or examination of the abdomen The colon may be totally obstructed for some days, the small intestine for three days, and yet both relieved by insertion of a tube into the distended bowel, secondary operation may be performed later if possible

End-to-side anastomosis between the ileum and colon furnishes an ideal opportunity for use of a Murphy button This anastomosis may be made for relief of obstruction or for fistula, or in preparation for removal of the right half of the colon, at the same operation or at a later time If side-to-side anastomosis is made, I have perforated the mesentery next to the distal part of the ileum, below the point of anastomosis, and have drawn adjacent tags of fat through the opening and around the bowel This serves as a living ligature, and induces the content of the small intestine to pass through the anastomosis instead of part of it passing into the cæcum

In removal of the right half of the colon in a single stage, I have found the danger to be tension from gas If, in performing end-to-side anastomosis of ileum and colon, the closed distal end of the colon is brought into the wound of closure of peritoneum and abdominal wall, and is held there by the invaginating sutures which previously have been brought through the adjacent omentum, an opportunity is given to perforate the colon in the one case out of six in which such a procedure is required on the third night or the fourth morning Without this preparation the procedure for relief would be delayed twenty-four hours to see if it was needed

The stimulus to contraction of open granulation tissue that is exerted by colon bacilli is not generally appreciated Fistulas of the small intestine rarely heal, but fistulas of the colon will continue to contract from the stimulation to formation of connective tissue exerted by colon bacilli until the large openings often close of themselves This contraction continues as long as there is exposed granulation tissue, but where there is union of skin and mucous membrane of the colon, as is made in colostomy, there is no contraction Murphy used to say "I wish I could extract out of the colon bacilli that which does it"

I have watched surgeons use great care to keep the mesenteric attachments adjusted exactly to each other in making an end-to-end anastomosis of the intestine This leaves two fat areas, without peritoneum, joined to each other If the bowel is rotated a quarter of an inch, an area with perfect peritoneal protection is joined to an area that has no such protection, union is immediate, and peristalsis is not interfered with in any way

In operating for gunshot wounds, after closure of perforations on the side of the bowel, additional protection can be given by rolling the bowel

against its own mesentery, nearby openings in the bowel, after their closure, can be sutured against each other and each can perforate into the other without symptoms or danger

In dividing the small intestine for anastomosis it should not be cut at right angles, but obliquely, on a slant of a quarter to a half inch, with the greater length of bowel on the mesenteric side, that this enlarged outlet may have a better blood supply on the part opposite the mesentery than a right-angled cut could give. Also, with an oblique cut, what is taken up by the suturing is provided for by the enlarged perimeter of the bowel. An opening of any size larger than the normal diameter of the bowel can be secured by splitting the bowel and cutting off the tips of the flaps.

Suturing of the small bowel is not so serious a matter as suturing of the large bowel. The small bowel must be water-tight, but the large bowel must be both gas- and water-tight, and, depending considerably on the age of the patient, the length of time of obstruction, and the condition of the bowel with regard to bacteria beneath the peritoneum, the least bruise or pinch may mean peritonitis. Dark bowel, if dull in color, will not live, but if dark bowel has a sheen and is not touched in such a way as to abrade its peritoneum, it has a fair chance of recovering.

It often is necessary to provide a vent for gases and fluids in the immediate neighborhood of anastomosis. The old Witzel method of inserting a catheter makes very efficient drainage. Many years ago I reported a simple method of preventing the drained intestine from adhering to the fixed parietal peritoneum around the point of insertion of the tube. By this method the tube is drawn through the omentum and through a perforation of the abdominal wall, say an inch to one side of the main abdominal incision. There seldom will be any leakage if tubes are brought to the exterior in this way, and usually a special procedure to aid closure is not necessary. The omentum is one tissue in the body which is always prepared for emergencies by having extra leucocytes available, all other tissues must wait for inflammation to produce an increase of leucocytes. The omentum will immediately take care of considerable infection, it furnishes two to four added layers of peritoneal surface, according to the point at which it is perforated.

Drainage of the stomach, or drainage of the upper part of the jejunum, is sometimes necessary following gastroenterostomy. In cases of chronic distention of the stomach from pyloric obstruction, at times parietic retention occurs following a perfectly carried out gastroenterostomy. This may require repeated gastric lavage, or it may be necessary to insert a Rehfuß tube into the stomach for gastric or duodenal drainage. Such troubles may require much attention for three weeks before the stomach will contract normally and take up its peristaltic action, gastric lavage alone, or insertion of a small tube, combined with patience, may be quite effectual. At times it may be advisable to perform jejunostomy and to insert a No. 8 or 10 catheter into the jejunum about twelve inches from its origin, one end of the catheter is brought out through a stab wound. The catheter is passed up the jejunum,

and on through the gastroenteric stoma. Before the catheter is introduced, an added opening is made in it four inches from the lower end, and when the catheter is in place this opening lies within the jejunum. When the projecting end of the catheter is closed, the opening mentioned allows the fluid content of the stomach to pass on down the alimentary tract. However, when the projecting end of the catheter is open, gastric content can be secured from it, for examination, and food can be introduced through it. Without the opening in the catheter, a second tube inserted two or three inches lower, and turned downward, gives opportunity, when they are united externally by a glass tube, to watch and also to test the content of the intestine. Such a tube may be used also for feeding, and for administration of fluid. Glucose solution and above all plenty of saline solution are required in such cases and are easy to give.

Sometimes the surgeon, in performing posterior gastroenterostomy, insists on placing the structures within the loop of the middle colic artery, when that loop is too small to allow such a procedure with safety, and a dropped stomach closes off the circulation. Twenty-five per cent of people have no anastomosis between the inferior and the superior mesenteric blood supply, this anomaly occurs in the region of the descending colon, or in that of the left side of the transverse colon. Any interference with the blood supply caused by injury of the middle colic arterial loop of such persons will lead to left mesenteric thrombosis. Such thrombosis was not uncommon twenty years ago following posterior gastroenterostomy, but now it is seen rarely. Colostomy involving the descending colon in the presence of this anomaly or when the mesentery is short may result in gangrene of the colon above the point of tension, and the circulation must be tested in such cases before the bowel is opened.

I like the Mikulicz operation for cancer of the left half of the colon. It is of advantage especially for cancer of the sigmoid, but when this operation cannot be used, resection of the sigmoid and again uniting the bowel over a large rubber tube passed through the rectum and out at the anus is a good procedure.

After resection of the colon it is of advantage to forestall tension exerted by gas retained in the lower bowel by dividing the sphincter with a cautery. Where division by knife would allow infection to enter, the cautery prevents infection, and scar tissue contracts at the end of six weeks, restoring good control. Primary colostomy often prevents distention in operations performed in two stages or in multiple stages. A vaccine prepared from colon bacilli and streptococci is of advantage in raising peritoneal resistance before operations on the large bowel in single stages.

It has been of great comfort to me to know when and where to employ these several procedures, of which I have developed but a few.

The higher the percentage of necropsies a surgeon is able to secure of those who die following operation, the lower will be his rate of mortality, because his knowledge will be increased by necropsy.

# THE ACTION OF MORPHINE ON THE SMALL INTESTINE AND ITS CLINICAL APPLICATION IN THE TREATMENT OF PERITONITIS AND INTESTINAL OBSTRUCTION

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MUCH time and energy have been expended in the study of the action of opium derivatives upon the gastro-intestinal tract. This study has established beyond doubt that morphine and other such alkaloids do have a definite effect upon the intestinal movements, although the exact mechanism of such effect may not be fully explained. Regardless of the exact mode of action of an opiate upon the muscle of the intestine the result of such action has been positively observed and with this information an estimate of its practical therapeutic value may with safety be made.

Renewed interest in the study of the action of opium derivatives upon the alimentary canal has recently been stimulated by Plant and Miller<sup>1</sup> and by Gruber and Robinson.<sup>2</sup> These writers have reviewed the subject thoroughly and have very convincingly established by their own researches that morphine has certain definite stimulating effect upon the smooth muscle of the bowel. Plant and Miller made their observations in unanæsthetized dogs with Thiry-Vella fistulas and in human beings with large thin-walled herniæ. They reported an increase in the general tone, an increase in the amplitude of rhythmic contractions and an increase in frequency and amplitude of peristaltic waves of the small bowel. They also noted an increase in the general tone of the colon musculature.<sup>3</sup> Gruber and Robinson likewise observed an increase in tone of the ileum after giving morphine sulphate intravenously to dogs. In their experiments repeated injections of morphine intravenously led to a decrease in general tone of the intestine and in some instances increased force of the rhythmic contractions. Dvorak and his associates<sup>4</sup> found an increase in intestinal tone and peristaltic activity in both animals and patients with and without bowel obstruction after giving moderate doses of morphine. Reid,<sup>5</sup> working in Ivy's laboratory, made the significant observation that hypertonic sodium chloride solutions injected intravenously increased the propulsive power of the intestine while morphine did not, although the latter increased the tone and rhythmic activity.

The constipating effect of opium and its derivatives is apparently due chiefly to its spastic effect on the sphincters, and perhaps to a decrease in the upper intestinal and pancreatic secretions.<sup>6, 7</sup> A delay in the progress of barium through the pylorus and ileocecal region has been satisfactorily demonstrated in both patients and animals after morphine administration.

It has long been believed by a majority of clinicians that opium and its alkaloids relax gastro-intestinal spasm and stop all peristalsis. With this in mind the drug has been liberally used to put the bowel at rest as a definite therapeutic measure in certain diseases involving the intestinal tract. The name of Alonzo Clark<sup>8</sup> stands prominently in surgical literature as an advocate of large doses of opium in the treatment of peritonitis. From his

observations, beginning in 1840, he conceived the idea "that to establish the narcotic effects of opium within safe limits, and continue them by repeated administration of the drug, would cure uncomplicated peritonitis—that a kind of saturation of the system with opium would be inconsistent with the progress of the inflammation, and would subdue it" The dosage of opium and morphine used by Clark varied within wide limits He began with small doses and increased them to produce a definite profound narcotic effect His direction to one of his house surgeons when treating cases of puerperal infection was to "narcotize those women within an inch of their lives" He recites the case of a ten-year-old boy with peritonitis lasting forty days in which the sulphate of morphia was gradually increased until the patient was receiving a grain and a quarter every forty minutes On the twelfth day of the disease, a woman was given 261 grains of opium These were apparently extreme cases, but illustrate the disregard which he had for quantity of the drug when a definite narcotizing effect was sought He says that "purgatives are entirely inadmissible The bowels should be left entirely at rest until they recover their muscular tone, then they will expel first the gas, and then the fæces, or if, after the inflammation is subdued, they do not move of their own accord, injections are admissible I have often left the bowels absolutely inactive for fourteen days without any recognizable consequence"

The popularity of Alonzo Clark's teaching was apparently somewhat overshadowed by the forceful declarations of Lawson Tait,<sup>9</sup> in 1892 Tait made the statements that "peritonitis is not a lesion which fits into the germ theory of disease at all, and it is no use talking about treating peritonitis, you have not a chance as a rule, you must prevent it" He discontinued the use of opium by mouth absolutely after abdominal operations and only occasionally gave one dose of morphine by hypodermic The basis of his treatment was through purgation for peritonitis, threatened peritonitis or "anything which seems to be likely to turn out peritonitis"

The opposing views of Alonzo Clark and Lawson Tait have both had ample support by surgeons through the years since 1840 with varying degrees of success In 1908, Stockton,<sup>10</sup> of Buffalo, emphasized the merits of morphine in the treatment of peritonitis and recited the case of a young girl eleven years of age to whom he gave the drug in doses of one-third to three grains at intervals of four to six hours In the same journal immediately following his article Bovee,<sup>11</sup> of Washington, stated that he was not a believer in the Alonzo Clark treatment of peritonitis by opium splints and preferred to withhold opium entirely if possible Crile and Lower<sup>12</sup> advocated deep morphinization in the treatment of acute appendicitis It was their conception that morphine prevented exhaustion of the kinetic system

The beneficial results claimed for the opium and morphine treatment of peritonitis have been based entirely upon false conceptions of the action of morphine upon the intestines More accurate knowledge of the action of this drug on the muscle of the bowel leads us to a new explanation of its usefulness in the therapy of acute peritonitis and obstructive lesions of the

intestines Wilen and Dragstedt<sup>13</sup> have very aptly remarked that the interpretation of its beneficial action in peritonitis must be on some other basis than that of abolishing intestinal activity and putting the intestine at rest

*Experimental Results*—In an effort to estimate the value of morphine and codeine in the treatment of peritonitis and intestinal obstruction we have repeated some of the experiments of Plant and Miller, using the Thiry-Vella fistula and in addition the Ivy-Mann fistula<sup>14 15</sup> in normal dogs and in dogs with obstructions of the jejunum<sup>16</sup> Morphine sulphate in doses comparable to therapeutic dosage in the human being definitely increased the bowel tone, the amplitude of the segmentation movements and initiated peristaltic waves Large doses abolished the peristaltic action and somewhat decreased the tone but did not affect the rhythmic contractions Very large doses increased the amplitude of the rhythmic segmentation movements It was interesting to note that the jejunum did not lose its power to respond to morphine stimulation even in moribund animals Kymographical tracings were made from both Thiry-Vella loops and obstructed portions of the bowel the day of obstruction and the day of death As long as the animal was alive, an intestinal response to morphine was obtained

The emptying time of the stomach and ileum was studied in dogs receiving barium before and after the administration of morphine by hypodermic injection The stomach content was delayed two hours after giving morphine Barium given through an ileostomy into the terminal ileum emptied in two hours without morphine After giving morphine all the barium remained in the terminal ileum at the end of two hours

Clinical observations confirmed the experimental findings that morphine definitely stimulates the activity of the small bowel This was strikingly demonstrated in a large thin-walled umbilical hernia The increase in activity was repeatedly noted after quarter-grain doses In an adult woman with lower abdominal peritonitis, accidentally receiving an overdose of morphine which reduced her respirations to six, definite bowel sounds could distinctly be heard The characteristic borborygmi of distended small intestine have been noticeably increased in several cases of acute peritonitis and intestinal obstruction Direct observation has been made of a portion of protruding terminal ileum following permanent ileostomy The increased activity of the visible portion of the gut was always noted after the average therapeutic dose of morphine by hypodermic injection

*Clinical Application of Experimental Findings*—One of the most dreaded features of the pathology of acute peritonitis and acute intestinal obstruction is the overdistention of the small bowel Patients seldom die with these diseases if distention of the stomach or small intestine does not exist Gatch and his co-workers<sup>17</sup> have impressed upon us the great importance of bowel distention, giving adequate reasons why overdistention may be an important lethal factor in obstructive lesions As the distention within the bowel increases, the circulation through its wall decreases Transperitoneal absorption of the toxic material found in the bowel in intestinal obstruction may



occur through a non-necrotic bowel wall rendered anæmic by distention. The contents of both obstructed and normal bowel are equally toxic<sup>18</sup>. Toxic substances found within the bowel are not absorbed unless there has been some damage to the bowel wall. A gut that retains its tone absorbs gases readily. A gut that retains its tone absorbs things it should absorb and does not absorb things it should not absorb. The rate of blood flow through the muscle probably increases its activity. The presence of peritoneal exudates on the bowel surfaces does not alone decrease peristalsis<sup>19</sup>. Distention is the essential factor in reducing bowel activity. In diseases, such as peritonitis and intestinal obstruction, which have as part of their pathology excessive bowel distention, any successful effort to combat such distention will prolong life. Any medication designed to relax or splint the bowel to prevent intestinal movement and the spread of infection is, in the present state of our knowledge concerning distention, founded upon erroneous premises.

Since morphine (and codeine) definitely stimulate the bowel tone and rhythmic contractions, its use is logical in peritonitis, paralytic ileus and bowel obstruction to prevent overdistention. Clinical experience has conclusively proven that there is no foundation for the supposition that such stimulated bowel activity spreads infection. If violent peristalsis be a danger, it is obviated in the use of large doses of morphine by the fact that such doses reduce peristaltic waves of the rush type, but still maintain an increase in tone and rhythmic movements. In addition to its action on the bowel, morphine relieves pain, restlessness, apprehension and the discomfort of thirst, thereby conserving the patient's strength and endurance.

The duration of morphine action on the bowel is at least six hours. Morphine given every four hours will, therefore, exert a continuous stimulating action. It is recommended in doses sufficiently large to keep the patient continuously drowsy and quiet during the height of the disease. The older clinicians who have used opium and its derivatives in the treatment of peritonitis emphasize the futility of timidity in its use. Its value is based upon a dosage sufficient to produce definite and continuous narcosis. Danger signals are respirations below twelve per minute or the appearance of cyanosis.

In addition to the use of morphine, special attention should be given to the maintenance of water, chemical and metabolic balance in the treatment of any intra-abdominal condition involving distention of the small bowel. It is well known that hypertonic solutions of sodium chloride given intravenously will stimulate bowel tone and peristalsis. Since this is true, it is reasonable to believe that a normal sodium chloride content of the body tissues will aid in maintaining proper muscle tone of the intestine. In the treatment of acute peritonitis secondary to intestinal-tract infections nothing is given by rectum during the acute stage. Water by mouth is given only to be removed at once by an indwelling siphonage or suction stomach or duodenal tube. When the infection is overcome the patient will usually begin to pass gas by bowel. At this time enemata may be given to aid in emptying the colon.

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As an aid in treatment and prognosis, frequent auscultation of the abdomen is recommended during the morphine treatment of abdominal distention. The presence of gas and liquid in a distended bowel gives a characteristic tinkling sound during bowel activity which is totally different from the more muffled sounds of the normally functioning gut.

Careful attention has been given to the consideration of any harmful effects of opium derivatives in the treatment of very ill patients with acute peritonitis and intestinal obstruction. The possibility of narcotic addiction is, of course, recognized. This should be a guarded but not a deterrent factor in the treatment. Slowing of respirations has not been harmful as far as can be determined by the observation of clinical cases. If morphine has any deleterious effect upon gland secretion, circulatory activity or general metabolism it is not evident clinically. Morphine given in large doses in experimental intestinal obstruction does not shorten the life of animals. This is also true of high jejunostomies which result in death in from two to six days.<sup>20</sup>

CONCLUSIONS — (1) Morphine and related opium derivatives when given hypodermically stimulate the tone, rhythmic contraction, and in some degree peristaltic waves of the small intestine for a period of at least six hours.

(2) To prevent overdilatation of the small intestine morphine is indicated in the treatment of acute peritonitis, intestinal obstruction and so-called paralytic ileus.

(3) The maximum clinical benefits can be obtained only by giving morphine in sufficient dosage to produce continuous narcosis.

(4) By maintaining the tone and rhythmic contractions of the small intestine with morphine, dilatation is controlled and disturbance of the bowel circulation is prevented during the course of the disease until the cause of the bowel dilatation is overcome by the natural defensive powers of the patient.

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DISCUSSION—DR J SHELTON HORSLEY (Richmond, Va) said he had seen some of Doctor Orr's work a few weeks ago. He saw the original tracings. The application of his experimental work is quite wide, it seemed to him, and it rather reverses one's preconceived ideas—at least his ideas—about the effect of morphine on the gastro-intestinal tract.

Morphine, if it tends to keep up the tone of the intestine, as he has seemed to show quite conclusively, both by experimental work and clinically, is not contraindicated in peritonitis as it used to be thought, but is positively indicated. It adds not only to the patient's comfort but to his physiological resistance.

DR ELLSWORTH ELIOT (New York City) reported the case in an adult of a spreading peritonitis in 1877, in which, after consultation with Dr Alonzo Clark, large doses of opium were administered without apparent effect on the course or duration of the infection. The patient died on the sixth day. A perforated gangrenous appendix with exterior abscess was found on autopsy. At that time no operations were done for this condition.

DR THOMAS G ORR said that in Alonzo Clark's articles he apparently had the notion that morphine had some specific effect upon peritonitis. Doctor Orr did not believe this to be correct. Morphine simply helps to prevent the abdominal distention until the patient can overcome his infection. Up to date we have no specific treatment for these conditions and we can only hope to support the patient until he can overcome them by his own resistance.

# BENIGN ENCAPSULATED TUMORS IN THE LATERAL VENTRICLES OF THE BRAIN    DIAGNOSIS AND TREATMENT

BY WALTER E. DANDY, M.D.

OF BALTIMORE, MD

FROM THE JOHNS HOPKINS UNIVERSITY

IN THIS communication thirteen benign encapsulated tumors in the lateral ventricles of the brain are reported. There are no signs or symptoms by which enucleable tumors can be differentiated from the invasive gliomata or other malignant types of tumor which protrude into or obliterate the ventricles.

From the literature twenty-five additional cases have been found, all of these have been post-mortem findings. None has been diagnosed during life or removed at operation. From an analysis of the signs and symptoms of the tumors in the literature together with those in my series there is no clinical syndrome by which these tumors can be localized with sufficient accuracy to be found at operation. It is true that some of them have hemiplegia, but this by no means permits accurate localization of the growth. All of these tumors can, however, be localized with absolute precision by means of ventriculography (Figs 1 and 2). When used correctly there is no danger whatever in this procedure. In our series all have been found at operation. Ten have been removed and the patients are well, three died from the effects of the operation. In the last nine cases there has been but one death. The longest survival period has been fourteen years. This chanced to be the first tumor that was localized by ventriculography.

Primary benign ventricular tumors occur in about 0.75 per cent of all brain tumors. They occur in any part of the lateral ventricles (Fig 3). The youngest patient was twelve, the oldest forty, they, therefore, occur during the period of youth. The duration of symptoms varied from five months to nine years, the average being one to two years. The only constant symptom is headache. There may be nausea, vomiting, diplopia, dizziness and papilloedema, all of which are purely indications of intracranial pressure. A positive Romberg or a history of staggering gait may mislead the operator into a diagnosis of a cerebellar tumor. Some degree of sensory or motor unilateral paralysis was present in about one-half of the cases.

*Character of the Tumors*—The tumors are of various types, most of them ependymal gliomata, but they are entirely different from the gliomata that arise in the cerebral tissue. They are well encapsulated, except at the small point of origin in the ependyma, and this is easily removable with the tumor. In none has there been recurrence. There have been two pure fibromata (Fig 4), these were the largest in the series, weighing 95 and 124 grams, respectively, and both grew out of the glomus of the choroid.

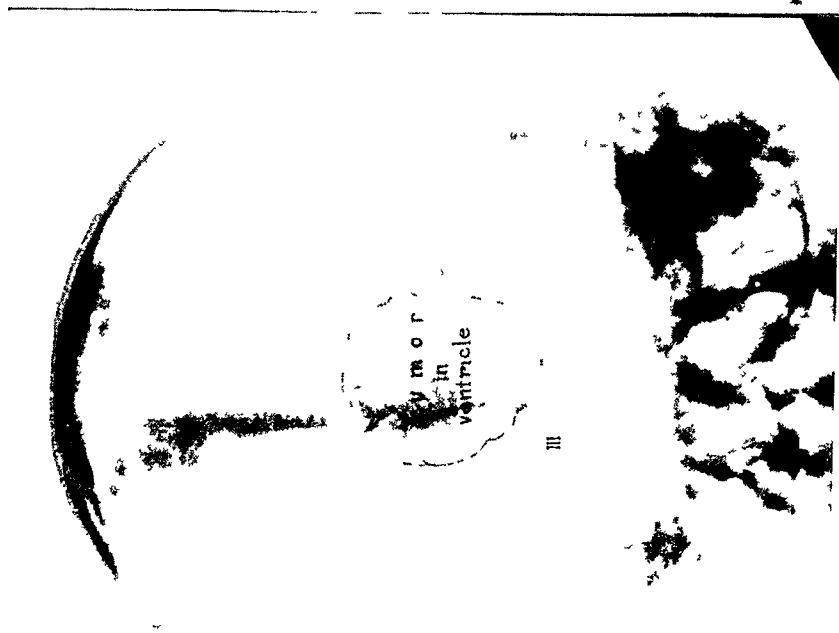


FIG 1

FIG 2

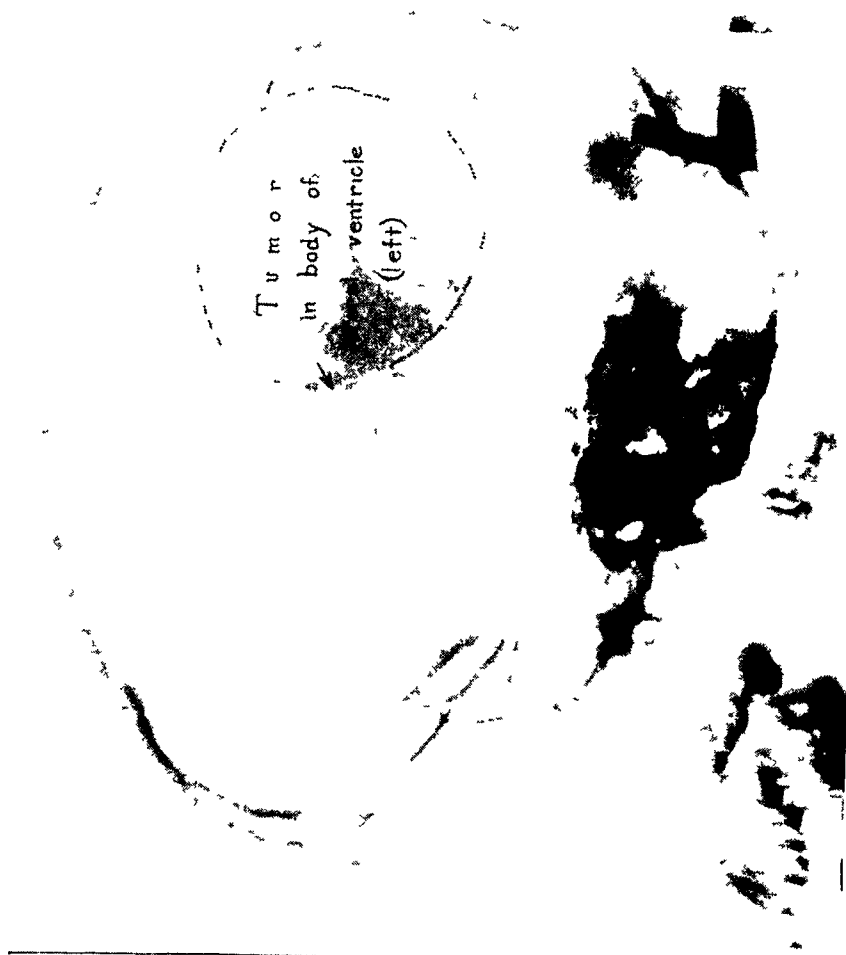


FIG 1 —Anteroposterior ventriculogram showing defect with a sharp oblique border in the right lateral ventricle. In addition there is a dislocation of the ventricular system to the left and obliquity of the third ventricle.  
 FIG 2 —Lateral ventriculogram showing sharp termination of the air shadow in the body of the left lateral ventricle

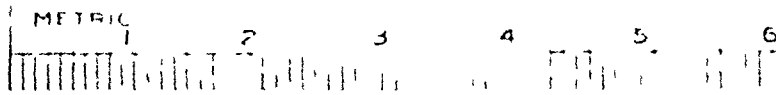


FIG 3—Tumor in right lateral ventricle causing preceding ventriculographic changes

plexus One tumor was an adenoma of the choroid plexus, and another was a venous aneurism in the wall of the body of the ventricle (Figs 5 and 6) This was completely extirpated following a second intracranial hæmorrhage with hemiplegia

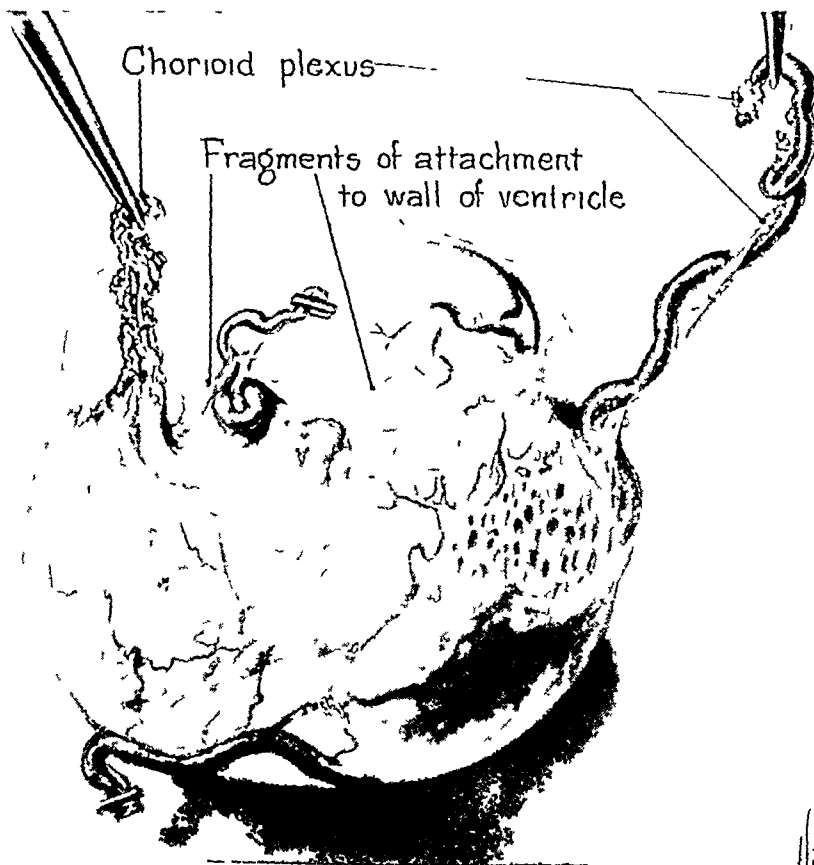


FIG 4—Tumor causing above ventriculographic changes It is a pure fibroma arising from the glomus of the choroid plexus

*Ventriculographic Findings*—These are of various types, depending upon the size and position of the tumor, always they are pathognomonic. A sharp line indicating the termination of the air shadow accurately marks one

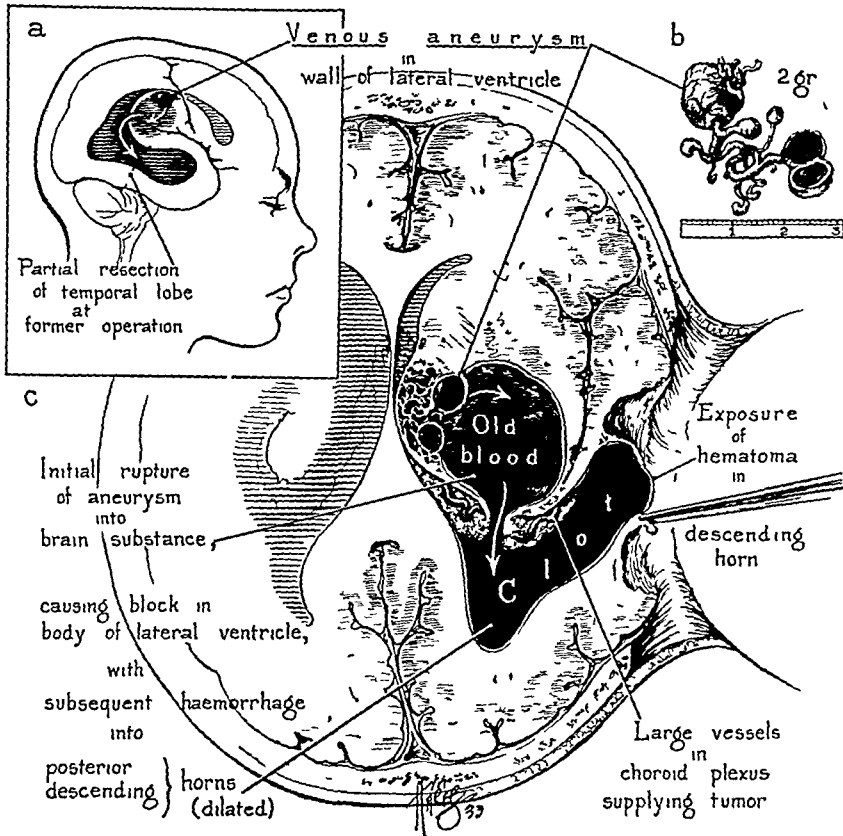


FIG 5—Venous aneurysm incorporated in the right ventricular wall. It had bled on two occasions producing hemiplegia. After removal of the hematoma the aneurysm was disclosed and removed.

pole of the tumor. A sharp straight or curved line suggests a benign type of tumor, but one cannot always be certain from the ventriculographical evidence alone that the tumor is of the encapsulated type. Always, there is

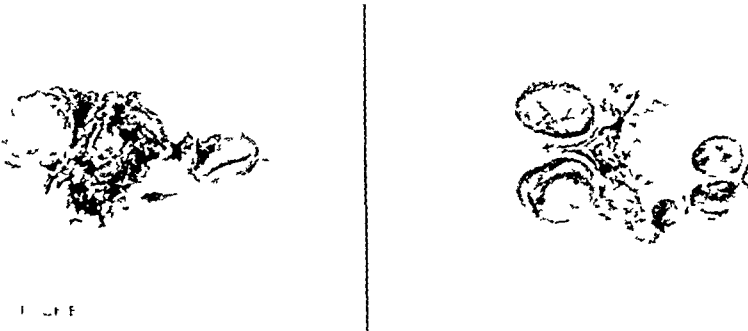


FIG 6—Photograph of aneurysm. There were several discrete venous pouches, as shown in the preceding Fig 5.

hydrocephalus distal to the tumor and caused by the obstruction of the ventricular system. A tumor may also block the ventricular system at a

## BENIGN TUMORS LATERAL VENTRICLES OF BRAIN

distance from the tumor, *i e*, by lateral compression of the aqueduct of Sylvius or the third ventricle

*Treatment*—A cure, of course, can be accomplished only by the removal of the tumor, and the earlier the diagnosis the better the patient's chances. It is always necessary to remove an area of cortex (Fig 7) either directly overlying the tumor, or if that part of the brain is silent, or if the tumor lies in the motor or another important area of the brain, the cortical defect must

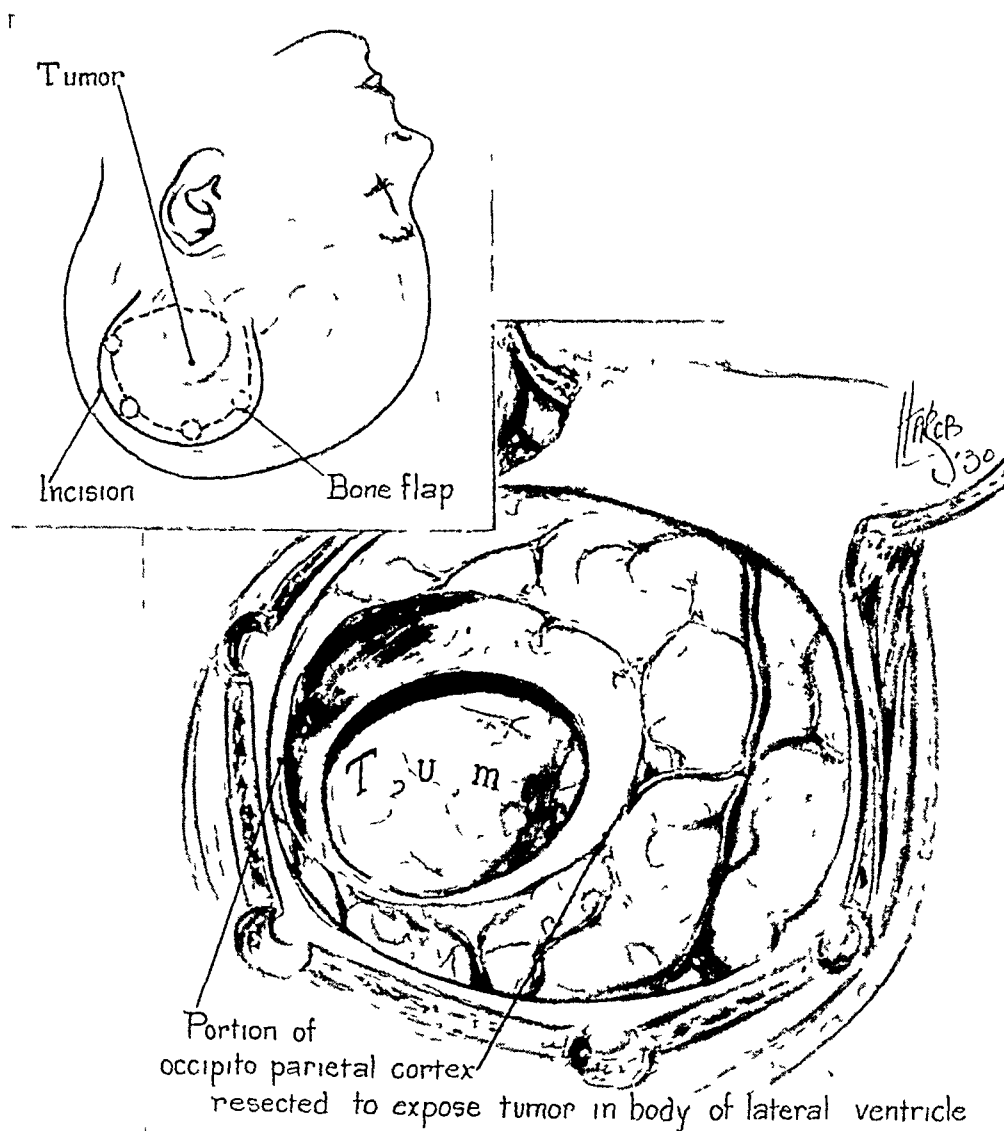


FIG 7—Operative approach to tumor, an area of cerebral cortex is resected in order to permit access to the growth

be made anterior or posterior to the tumor and enucleation may be made through this defect

*DISCUSSION*—DR GEORGE J HEUER (New York City) remarked upon the enormous contribution which ventriculography had made to the diagnosis of certain brain tumors. He recalled in his own experience how impossible it was to make a diagnosis of an intraventricular tumor and that these cases were operated upon sometimes when the tumor was not found. They eventually came to autopsy and at that time the tumor was discovered. It is an illustration, he thought, of the advances that are being made in neurosurgery.



# ORIGIN AND COURSE OF INFECTION IN SUBPHRENIC ABSCESS

BY PHILEMON E. TRUESDALE, M.D.

OF FALL RIVER, MASS.

THERE has been considerable discussion as to the avenue by which infection reaches the diaphragm. Although there are many sources from which infection may extend to the diaphragm to produce abscess, such as appendicitis, perforated peptic ulcer, cholecystitis, ruptured diverticulitis, furunculosis, and other septic foci in the body, the most common site of origin is either an appendiceal abscess or a perforated peptic ulcer. In 890 observations, Piquand<sup>1</sup> found 251 cases of gastric origin, 191 appendiceal, 131 hepatic, fifty intestinal, forty splenic, twenty-seven pancreatic, twenty-six renal, seventeen genital, and thirty-two originating in the thorax. These figures agree with statistics compiled by Barnard,<sup>2</sup> Lockwood,<sup>3</sup> and Fifield and Love,<sup>4</sup> who name peptic ulcer, biliary disease and appendicitis as the principal sources of infection.

From a study of our own twelve cases of subphrenic abscess and from opinions expressed by contemporary authors, we are led to believe that the most common channel of infection is by way of the lymphatics. In studying their function as conveyors of infection it is difficult to determine the exact anatomical relationships involved. To secure a clear picture of lymphatic distribution it is essential to review the methods by which the lymphatic system was outlined by three investigators during the previous century.

First was the method of Mascagni,<sup>5</sup> which was published near the close of the Eighteenth century. It consisted of the injection of a colored solution of gelatin into the arteries. The solution after filling the blood-vessels passed through their walls, permeated the surrounding tissues, and was taken up by the lymphatics. Dilated by this liquid, which soon coagulated, the lymphatic vessels were made to stand out quite clearly. Then they were injected with mercury and traced throughout the course of their small branches. This method was incomplete, however, because it did not show the lymphatic trunks nor the entire network of capillaries. Thus at the end of the Eighteenth century we knew how the lymphatics united in their course and how they terminated, but not their origin. Mascagni left this great problem for his successors to solve.

The second method of showing the lymphatics appeared in 1830. It was introduced by Gohmann and Panizza.<sup>6</sup> After injecting mercury under the skin, mucous membrane, or serosa, they dissected up these layers and found the anastomosis of the first radicles of the lymphatic system. But this brilliant network did not include the lymphatic trunks. Viewed with the naked eye they appeared excellent, but under the microscope they lost all importance because they seemed to indicate that lymphatic trunks did not exist.

The German method was applied to the absorbent epithelium of the vessels. By the use of silver nitrate, von Recklinghausen,<sup>7</sup> in 1865, outlined this layer of cells and made it possible to examine the vessels under the microscope. This method offered great hopes, particularly in demonstrating the star-shaped cells indicating the origin of the lymphatic capillaries. But this silver stain often gave a result that was variable and a picture

## SUBPHRENIC ABSCESS

difficult to interpret. It possessed distinct advantages and was used about twelve years, but it was still an intermediate step.

Sappey's<sup>8</sup> researches in 1874 differed entirely from those which had preceded. In order to bring the vessels into plain view, he did not direct his attention to the wall of the vessels but to their contents. He used the lymph itself as a means of investigation. He believed that if he could color the contained lymph, it would offer the best agent for determining the source from which it came. After lengthy and laborious study, he found a suitable color which imparted a dark tint and appeared almost black. Presently the flow of lymph through a network of transparent threads produced a deep tint in separating perfectly on the background of the preparation. Thus to the observer the conditions presented were similar to those of the capillaries when naturally or artificially injected. In this manner Sappey obtained the greatest degree of enlargement of the vessels and revealed the lymphatic trunks.

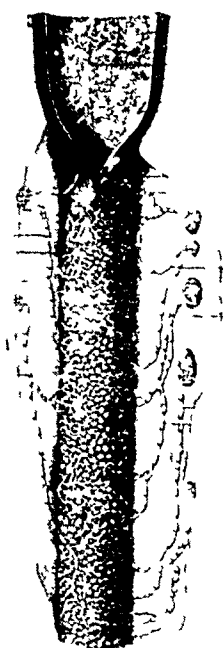


FIG 1

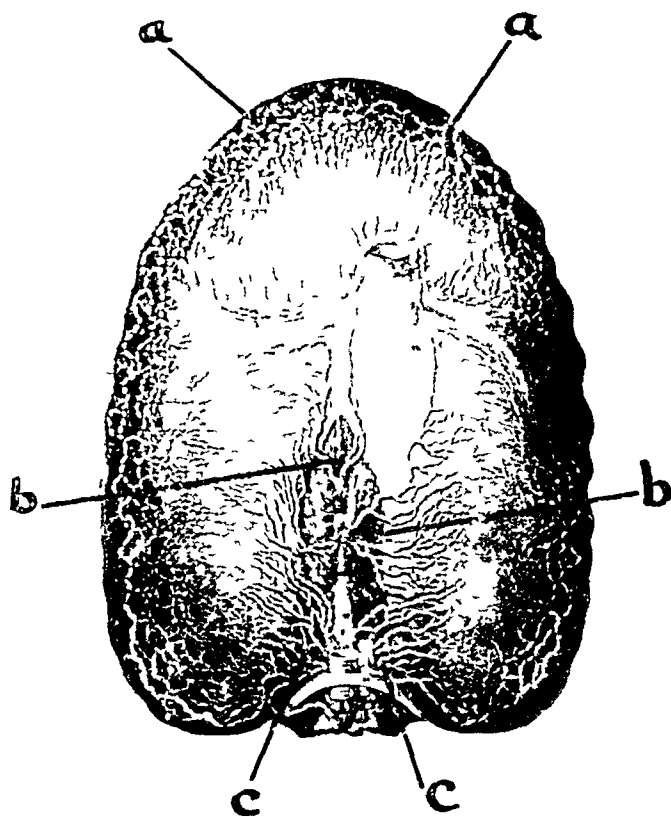


FIG 2

Following these collective researches, MacCallum,<sup>9</sup> of Johns Hopkins, in 1903, may be considered to have contributed more than any of his predecessors to our knowledge of the complicated process by which granular materials are absorbed by the diaphragm through the peritoneum under normal and pathological conditions. He chose the diaphragm as the most important absorbing area of the peritoneum and studied in detail the anatomy of the tissues which separate the lumen of the lymphatic channels from the cavity of the peritoneum. On the pleural surface of the diaphragm the lymphatics anastomose abundantly and form a network over the whole surface. On the peritoneal side the lymphatics are arranged differently. In their arching course they lie in spaces between the connective-tissue fibres and are separated from the peritoneal cavity by an extraordinarily thin layer of tissue. These thin areas form the most favorable site for the entrance of materials from the peritoneum. These sac-like channels appear as small, diamond-shaped clear areas and are plainly seen in the accompanying illustration of the oesophagus (Fig 1). When granular material is injected into the peritoneal cavity,

we find that these blind sacs or *lacunæ* in the diaphragm become injected with the granular substance, and from them we can trace the material into the anastomosing trunks of the pleural network, then into the efferent trunks, and on into the mediastinal lymph-glands

MacCallum studied this tissue further by employing thin paraffin sections fixed in Zenker's fluid. The lymphatics were injected with an 0.5 per cent solution of silver nitrate followed by agar which when cooled kept the channels widely distended. In this way the smoothly stretched lining could be studied. It was discovered that the endothelial lining of the lymphatics was complete with no perforations, and that the peritoneal

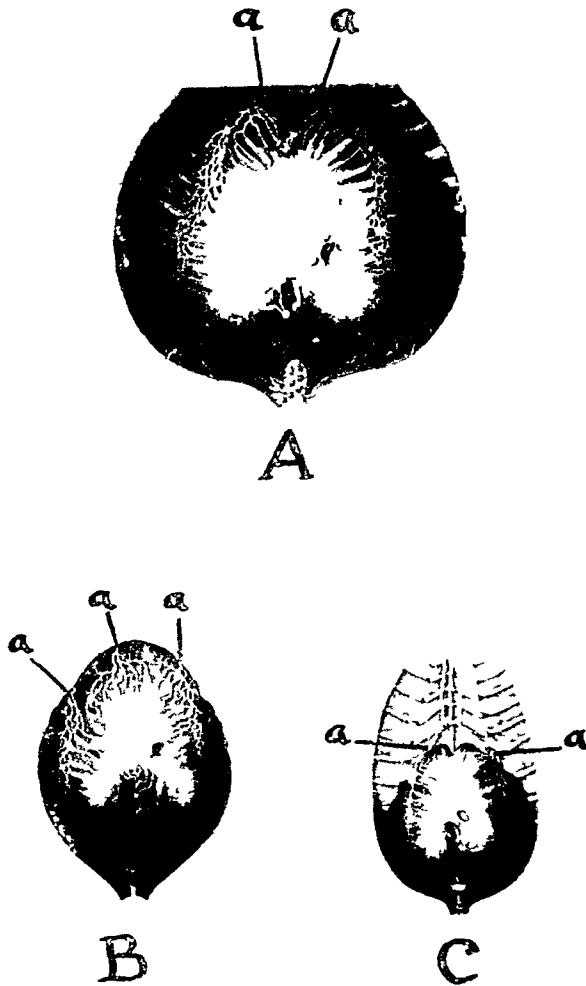


FIG 3

epithelium like the lymphatic endothelium was a complete membrane. The nature of the tissue between the peritoneal epithelium and the endothelium of the lymphatics was next studied. This basement membrane was demonstrated by Bizzozero,<sup>10</sup> Vincenzi,<sup>11</sup> and Muscatello,<sup>12</sup> who macerated the tissue in Muller's fluid and alcohol and found that it could then be readily torn away in small strips. MacCallum found no communication between this basement membrane and the lymphatic *lacunæ*. These *lacunæ* were the absorbing terminals of the diaphragmatic lymphatics, had a complete lining endothelium, and were separated from the peritoneal cavity by loosely woven connective tissue and the peritoneal epithelium.

## SUBPHRENIC ABSCESS

MacCallum was forced to conclude that absorption of granular material was brought about by phagocytosis. He demonstrated this by injecting a suspension of carmine into the peritoneum of a rabbit. After a few hours, examination of the diaphragm showed the *lacunæ* sprinkled over with leucocytes which swarmed over the surface of the *lacunæ* and could be seen in large numbers making their way with the load of pigment through the roof of the *lacunæ*. Finally, the endothelial cells in the lymphatics became swollen with pigment.

CHART

ANALYSIS OF CASES					
Total Number Cases			12		
I Sex	(a) Males	8	(b) Females	4	
II Age	(a) Oldest	72	(b) Youngest	20	(c) Average 44 5
III Symptoms	(a) Septic temperature				12
	(b) Definite leucocytosis				11
	(c) Local pain and tenderness				12
	(d) Evidence of fluid in chest				3
	(e) Referred pain to shoulder				3
	(f) Fecal expectoration				4
IV Cause	A Following initial operation, for—				8
	(a) Acute suppurative appendicitis				4
	(b) Perforated duodenal ulcer				2
	(c) Acute cholecystitis				1
	(d) Carcinoma of oesophagus				1
	B Abscess present on entry, origin undetermined				4
V Type of Drainage	(a) Thoracic				5
	(b) Abdominal				5
	(c) Abscess undrained				2
VI Result	(a) Died				9
	(b) Recovered				3
VII Operative mortality					70 %
Total mortality					75 %

Although MacCallum observed that individual cells could be separated by respiratory movements and fine granules forced between them, he found no support for the statement that there exists open communication between the peritoneum and the lymphatics and proved that the peritoneum is not a part of the lymphatic system. Each of these structures is lined with cells which retain their specificity throughout and nowhere merge into one another.

These investigations by MacCallum have not been disproved so far as we know.

The diaphragm of the horse, as injected by Sappey, owing to its enormous development, provides a good illustration of the origin of the lymphatic network covering the muscle fibers and accompanying them to the lymphatic trunks into which they drain. (See Fig 2.) These comprise two anterior groups, *a a*, five trunks which lie centrally and give off branches that com-

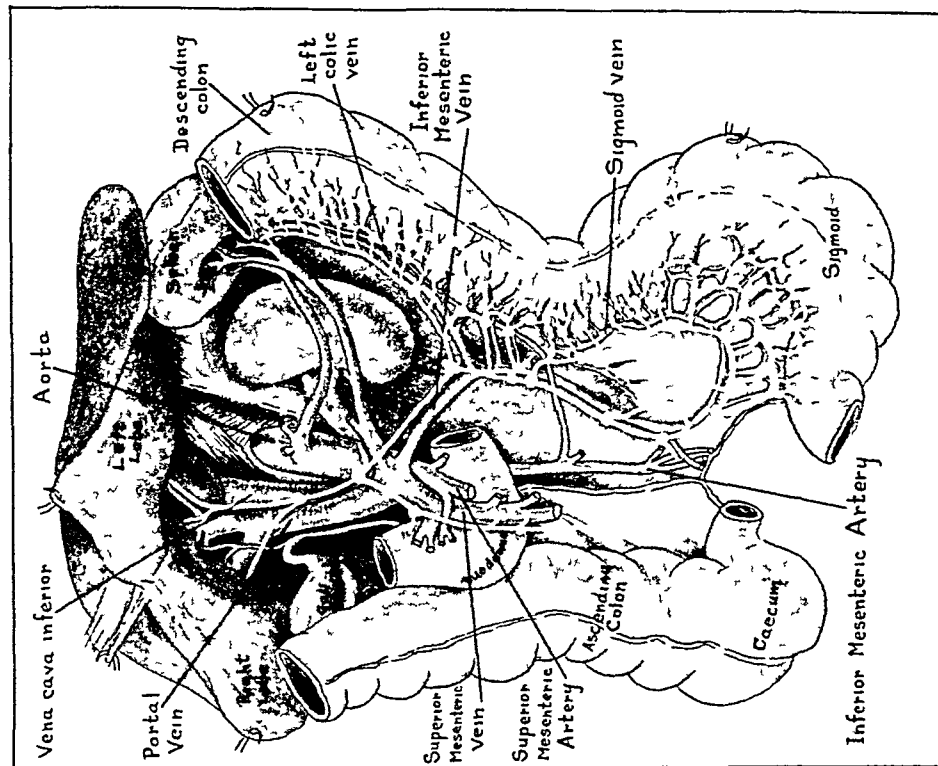


FIG. 5

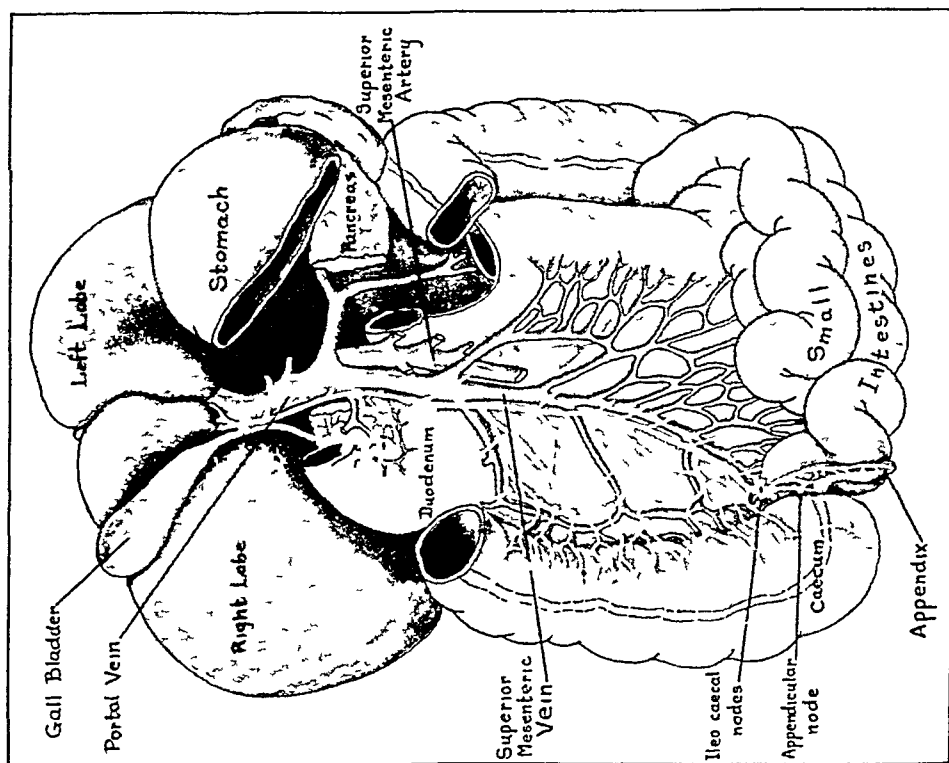


FIG. 4

## SUBPHRENIC ABSCESS

municate with glands located around the vena cava, *b b*, and five or six aortic trunks which lie posteriorly on either side, *c c*

The next figure (Fig 3) illustrates the lymphatic system in the diaphragm of a man, *A*, a dog, *B*, and a rabbit, *C*. In the rabbit the lymphatic system is as highly developed as in the dog. In both the arrangement is similar even in the anterior portions. In man, however, the two anterior groups *a a*, continue in closer relation with the mammary veins. In addition, one or two independent vessels are found between the two groups of main trunks which empty into the same vessels. In observing the myriads

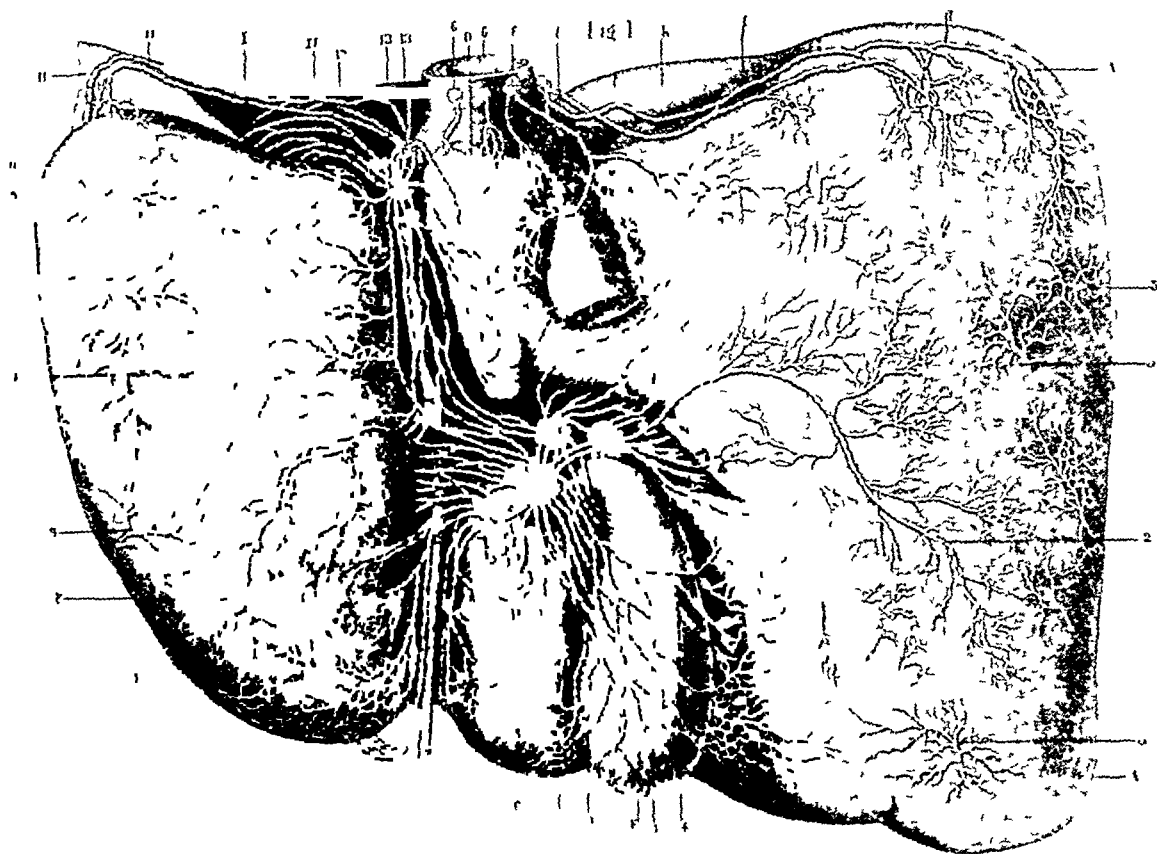


FIG 6

of small vessels contiguous and superimposed, one is surprised to find so many vessels in so thin a membrane

The chart on page 849 contains a list of twelve cases of subphrenic abscess recorded at the Truesdale Hospital. In seven of the twelve cases the focus of infection was within the peritoneal cavity, in one case within the thorax, and in four undetermined, though in each the history was suggestive of an intestinal lesion. Four of the intraperitoneal cases followed operation for appendiceal abscess.

Since the majority of these cases developed as a sequela of appendicitis, we have studied the lymphatics in their course from the appendix to their distribution in the region about the diaphragm. The bacillus-laden lymph passes from the appendiceal abscess to the appendicular nodes which communicate with the ileocecal nodes. The stream then empties into the

lymphatic trunk following the superior mesenteric vein (Fig 4) which in turn empties into the portal vein

Likewise a focus of infection at any point in the descending colon would gain access to the lymph channels accompanying the inferior mesenteric vein (Fig 5), which finds its way into the superior mesenteric vein before emptying into the portal vein. Thus the lymphatics draining the entire colon



FIG 7

(Sappey)

reach the liver in juxtaposition with the mesenteric veins. This course of the lymphatics offers an explanation for the frequency of extension of malignant disease from the colon to the liver.

When the lymphatic vessels reach the liver they pursue a most intricate course. Their distribution is seen in detail in the next two illustrations.

On the inferior surface of the liver (Fig 6) there are six principal trunks. Those which arise mainly from the right lobe of the liver (A)

## SUBPHRENIC ABSCESS

terminate in nodes surrounding the vena cava (1, 1, 6, 6, 6) Trunks 2, 3, 4, and 7 empty into nodes 15 resting on the neck of the gall-bladder. Deeper branches 5, 9, disappear in the liver to follow branches of the portal vein. Trunk 8 is the principal trunk of the left lobe (*B*). Trunks 10, 11, 12, and 13 come from the superior surface of the liver and terminate in nodes in the posterior part of the longitudinal fissure. Still other lymphatic trunks connect with the terminal part of the œsophagus, 14.

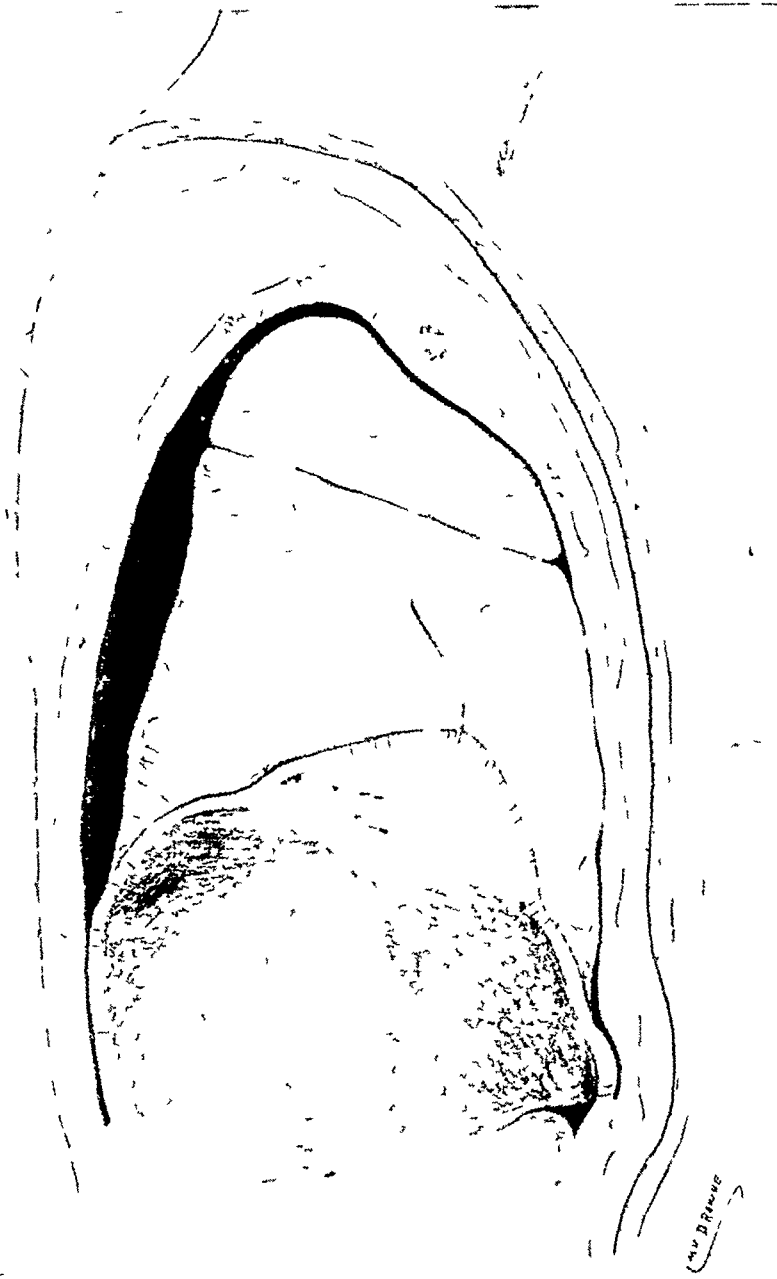


FIG 8

A more diffuse distribution of the lymphatics is noted on the superior surface of the liver (Fig 7). The collecting stems are more conspicuous on the right lobe (*A*) than on the left (*B*). They pass forward and downward, 1, 2, as they curve around the anterior border of the liver and join stems from the gall-bladder, which pass into the hepatic nodes in the transverse fissure. In the anterior view (*A*, *B*, *C* in Fig 7) the dense net-



work of lymphatic vessels is seen along the line of attachment of the falciform ligament. In Fig B, side view, some lymphatic trunks are seen passing backward along the vena cava and through the diaphragm, others pass between the layers of the falciform ligament toward the under surface of the diaphragm. Figure C shows a cross-section through the liver. The lymphatic vessels are seen accompanying branches of the portal vein.

The lymphatic vessels which pass through the diaphragm finally terminate in the lower nodes of the inferior deep cervical group. Thus a direct route is provided for the metastasis of the supraclavicular nodes frequently induced by abdominal carcinomata, and since these stems also communicate with the lymphatics of the pleural surface of the diaphragm, which are closely associated with the thoracic vessels, opportunity is afforded for the development of pleuritis as a result of a subdiaphragmatic abscess.

After coursing through the liver the lymphatic vessels continue their route and finally reach the diaphragm with their infected lymph. Localizing above the liver, the infection develops into an abscess. Fig 8 shows a subphrenic abscess with the superimposed right lung adherent to it. By blunt dissection the lung was separated from the diaphragm, revealing the site of rupture of the abscess where it communicated with the lung, a frequent channel of evacuation. The lung was peeled back to make the abscess accessible for drainage.

*Summary*—The lymphatics are the common carriers of infection from the peritoneal cavity to the liver and diaphragm.

The diaphragm is richly supplied with lymphatics and on its peritoneal aspect is found an elaborate network of lymph-vessels which promotes rapid absorption.

The channels through which infection reaches the liver and diaphragm from the ileocecal region and the descending colon are quite clearly demonstrable.

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- <sup>11</sup> Vincenzi. *Ibid*.
- <sup>12</sup> Muscatello. *Ibid*.

# VESTIGIAL MASTITIS

A HITHERTO UNRECOGNIZED SYNDROME

By ALEXIS V MOSCHCOWITZ, M D

of New York, N Y

IN ORDER to obviate all misconception, it is necessary to state at the outset that the lesion I am about to describe has nothing whatever to do with the somewhat hackneyed subject of supernumerary or aberrant breasts, hyperthelie, *etc* The only relation between vestigial mastitis and the latter conditions is that both originate from a common embryonal anlage

My theme will perhaps be easier to follow if I first submit short abstracts from the clinical histories of my cases

CASE I—Mrs M M, thirty-nine years of age, was referred to me by Dr Eli Moschcowitz April 29, 1930, because of a tumor in the left breast which had existed without any appreciable change for a number of months The tumor, about the size of a hazel-nut, presented the characteristics of an innocent fibro-adenoma and I did not hesitate to express myself in this manner and to reassure the patient The tumor was located in the mamillary line, close to the inferior periphery of the breast When my examination was completed, the patient casually called my attention to a peculiar, very shallow and very narrow groove which she had noticed during the past few months, and which extended, roughly speaking, from the upper margin of the breast in a rather graceful curve towards the corresponding axilla This groove was about six inches long and was slightly tender on pressure Never having encountered a groove of a similar nature, I continued my examination with particular care Much to my surprise, I now discovered upon the abdomen not a groove like the one just described, but a cord, which began at the lower border of the breast, approximately, at the location of the previously described fibro-adenoma and which coursed in the general direction of the symphysis pubis As far as it was traceable,

this line was about eight inches long and gradually faded away (Fig 1) It felt rather wiry and not unlike an adult vas deferens, but perhaps a trifle thinner I particularly want to mention that this cord was not intracutaneous but distinctly subcutaneous, apparently within the fatty layer of the anterior abdominal wall It was somewhat tender to pressure In the presence of these additional findings, a justifiable doubt arose in my mind as to the correctness of my preliminary diagnosis of fibro-adenoma, and it occurred to me that the abdominal cord might be an aberrant lymphatic vessel containing a carcinomatous deposit, secondary to a possibly malignant tumor of the breast This

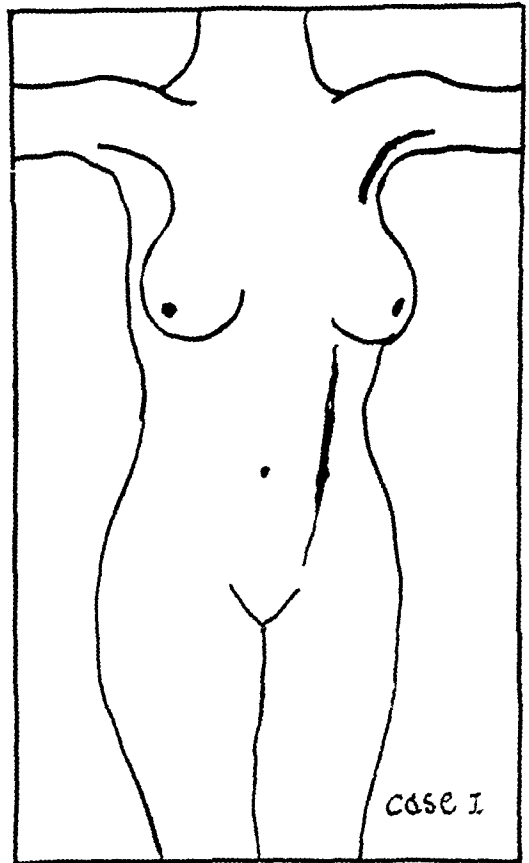


FIG 1—(Case I) Note the presence of a supramammary cord and an infra mammary cord on left side

appeared to me rather more than plausible because of the peculiar location of the intramammary tumor, namely, close to the inferior margin of the breast. I explained my fear to the patient and urged exploration of the tumor. I also suggested the advisability of excising a small bit of the abdominal cord for microscopical examination.

Operation, May 6, 1930. The breast tumor was excised and was pronounced to be a fibro-adenoma. At the time of the operation, the cord in the anterior abdominal wall could no longer be recognized as a definite cord. An excised portion resembled somewhat firm infiltrated fat. The specimen excised from the abdominal wall which was at a considerable depth below the cutis was examined by Dr. Paul Klemperer,\* Pathologist to Mount Sinai Hospital, and described in the following words:

"Section 4052, No. 2 (Figs. 2 and 3) shows several fragments of fat tissue, one of which includes tubular structures cut in longitudinal and cross-section. These tubular structures are lying within a connective-tissue matrix and are occasionally surrounded by a considerable number of lymphocytes intermingled with sporadic polymorphonuclear leucocytes and rare plasma-cells. These tubular structures vary in width, the widest contains some pink-staining amorphous material. The epithelial lining of this particular duct consists of flattened cells with cylindrical nuclei. Within the same connective-tissue stratum, there are similar ductlets which have a capillary lumen and are lined by columnar cells with rather pale nuclei. In one of the adjacent connective-tissue areas, there are numerous other cross-sections of ducts which are lined by columnar epithelium. These epithelial structures closely resemble the smaller ducts found in atrophic mammary tissue. There are no actual lobules present. The cellular infiltration of the stroma suggests a mild inflammatory process."

I see the patient at frequent intervals. Even a meticulous examination and palpation of both the supramammary and inframammary regions fail to reveal the slightest abnormality, nor does the patient complain in any manner. In parenthesis, I wish to mention at this point that I have noted similarly a complete disappearance of the definitely palpated cord in several other instances. I account for this phenomenon by assuming that the cord is palpable only when, for some hitherto unexplained reason, it is either inflamed or otherwise changed pathologically, as is evidenced by the specimen above described, and that upon the cessation of the inflammation it eludes detection, even though de facto it is still present. I wish to call particular attention to the fact that in the specimen obtained from this patient there is still in evidence a marked round-cell infiltration, a finding indicative of an inflammatory process. This inflammatory process, to my mind, also accounts for the pain of which all of these patients complain and which is the particular symptom which prompts them to seek medical advice.

CASE II—Mrs. K. B., thirty-six years of age, was referred to me October 5, 1930, complaining of pain in the left half of the abdomen, without any more definite localization. Examination carried out punctiliously failed to reveal anything of a pathological nature within the abdomen. I was about to abandon all further efforts in quest of a diagnosis and seriously entertained the question of malingering. In order to exclude this eventuality I examined the patient, as I am accustomed to do for obvious reasons, while I directed her to contract her abdominal muscles. In executing this manoeuvre, my palpating fingers suddenly felt a cord which was located just about in front of the outer edge of the left rectus abdominis. The cord felt wiry, something like a thin vas deferens, its general direction was, I should say, on a line between the left nipple and the symphysis pubis. I could trace it for a distance of about eight inches and it faded away at both ends. (Fig. 4.) It was tender on pressure, but only when pressed against a firm base, in this instance the contracted abdominal muscles. During the exami-

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\*I avail myself of this opportunity to express my gratitude to Doctor Klemperer for the manifold pathological examinations, as well as other favors in the course of the preparation of this paper.

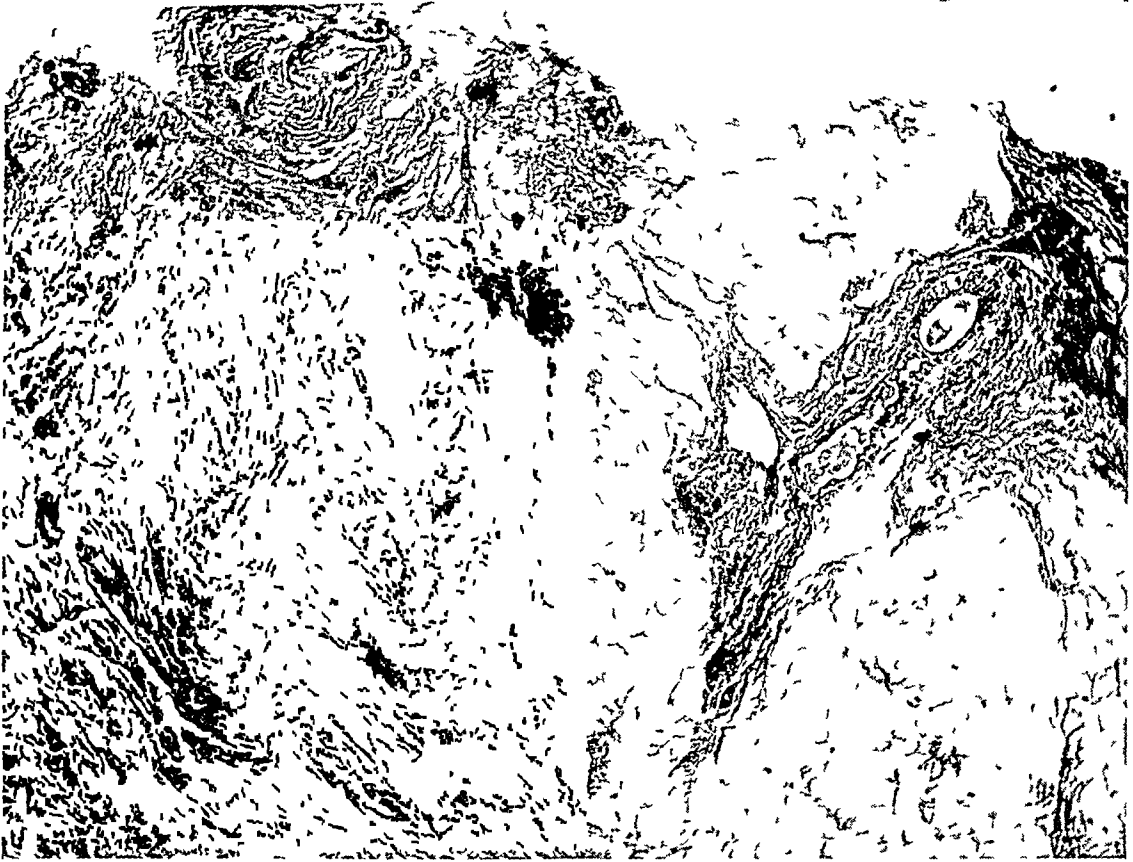


FIG 2—Section of inframammary cord in Case I Low power

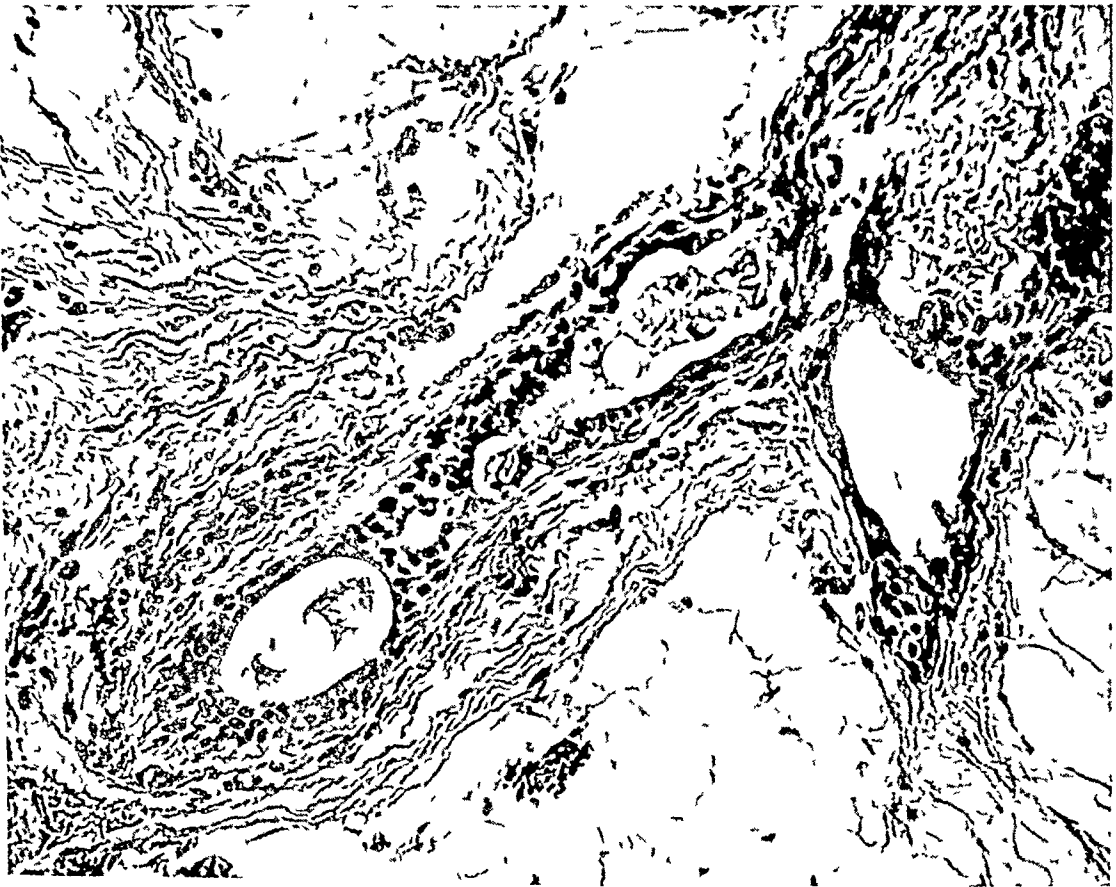


FIG 3—Section of inframammary cord in Case I High power

nation, the patient volunteered the information that this was the pain of which she complained and for the relief of which she sought advice. I repeated my examination at weekly intervals and was thus repeatedly able to confirm my findings. On reexamining the patient about six months later, I could no longer find any trace of the cord and the patient considered herself well.

CASE III—Dr C consulted me in December, 1931, as to the nature of a peculiar cord which he discovered by accident in the left axilla. In reality, the discovery was not wholly accidental, because on closer questioning the patient confessed that the self-examination which led to the discovery of the cord was induced by a sense of discomfort in the region mentioned. Dr C considered the cord to be an inflamed lymphatic vessel, presumably secondary to a tiny pustule on the outer aspect of the arm. Some

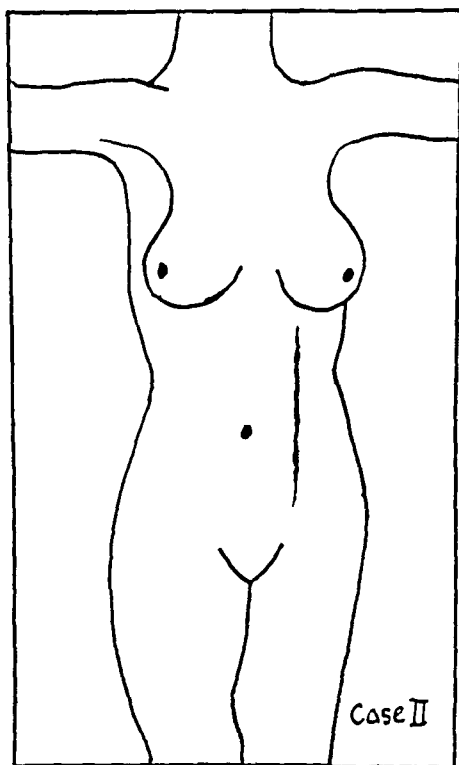


FIG 4—(Case II) Note long infra-mammary cord on left side

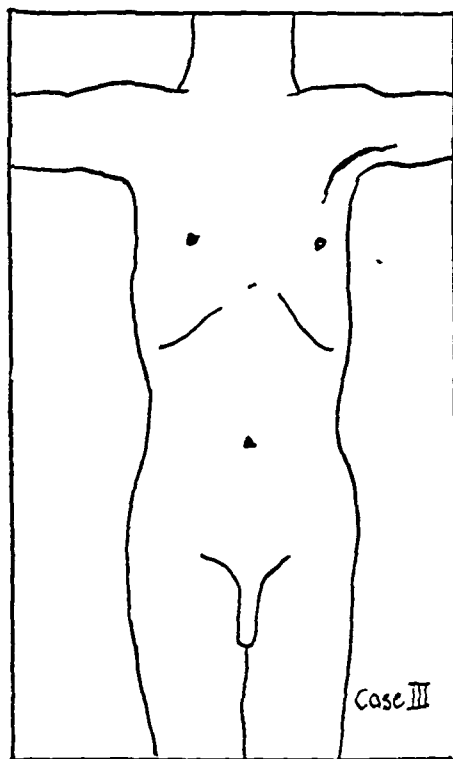


FIG 5—(Case III) Note supra-mammary cord on left side

time after Dr C's first visit, he imparted to me the additional highly interesting information that he recollects that at the age of fifteen he was under treatment for a painful swelling of the breast, accompanied by a serous discharge from the nipple.

Physical examination revealed the pustule previously alluded to. In addition, there was to be palpated a cord-like structure about five inches in length which ran parallel with the inferior border of the pectoralis major in the anterior axillary space toward the chest-wall and then curved gradually downward towards the breast (Fig 5). Both ends gradually faded away into the surrounding tissues. At this point, I again wish to emphasize that the cord was definitely subcutaneous and not intracutaneous. I can give no better description of the cord than by reiterating that it felt like an adult vas deferens. Dr C, never having heard of such a possibility, doubted the correctness of my diagnosis and rejected my suggestion to excise a small portion of the cord for microscopical examination. Incidentally, I cannot quite blame the patient for his lack of cooperation, because I assured him that the cord would disappear in the course of

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time My last examination took place November 12, 1932, and revealed nothing abnormal

CASE IV—In February, 1932, I was requested by Dr Leon Ginzburg to see Miss R A, nineteen years of age, a patient in the Out-Patient Department of Mount Sinai Hospital, who gave the following history Three weeks ago, she had an attack of influenza Shortly thereafter, she began to complain of pain in the right axillary region To use her own words "She felt as if she were getting a boil" Upon examining herself, she discovered a painful strand in the axilla Physical examination revealed a cord about six inches in length in the anterior part of the axilla, which at first ran parallel with the inferior border of the pectoralis major, and upon reaching the chest-wall curved gradually downward in the general direction of the breast (Fig 6) The cord felt just about like an adult vas deferens, and was rather tender I dem-

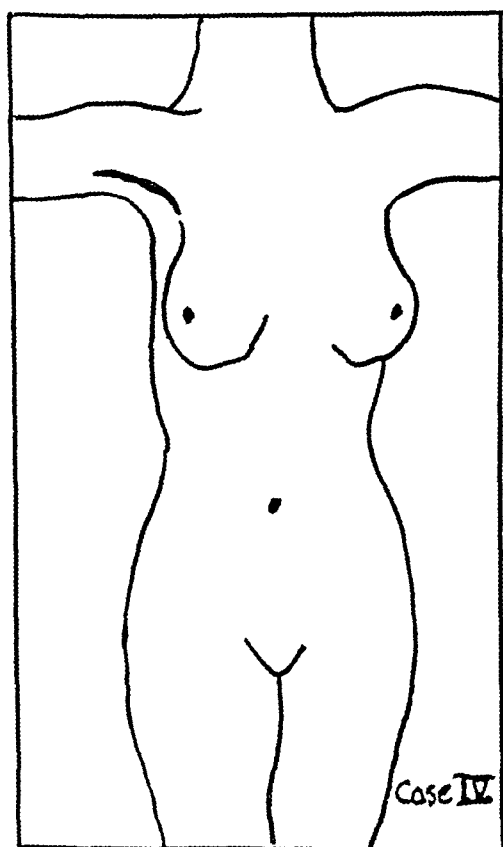


FIG 6—(Case IV) Note supramammary cord on right side

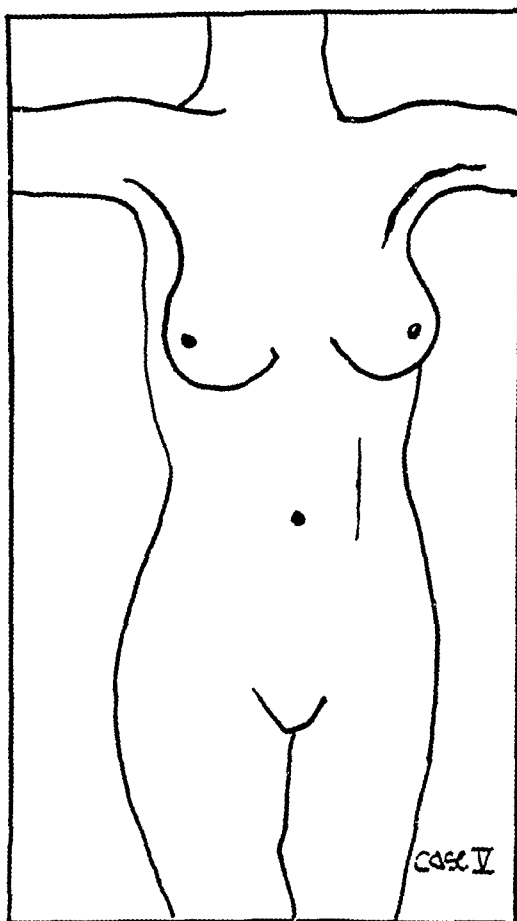


FIG 7—(Case V) Note supramammary cord and inframammary cord on left side

onstrated the patient to several colleagues who chanced to be present When I wished to reexamine her, I made heroic efforts to trace her, but greatly to my regret, as is so frequently the case with the shifting population in a large city, I was unable to do so

CASE V—Mrs Rose P, thirty-eight years of age, consulted me November 5, 1932 Several years ago, I operated upon her sister, on which occasion I extirpated a supernumerary breast from the left axilla, and she still has a supernumerary breast in the right axilla The patient under discussion now states that for the past four years she has suffered intermittent pain in the left breast and axilla radiating down the arm In the beginning, she was under treatment in the Out-Patient Department of the Lenox Hill Hospital About one year ago, she noticed that she could not lift the left arm as fully as the right, nor as fully as she was able to do formerly, as she states, "because

there was something that was pulling her arm down" More recently, she was under treatment at the Post-Graduate Hospital and was advised to discontinue the use of her arm and to report in two weeks Her pain, general discomfort and functional disability continued unabated

My physical examination revealed the following status of interest When the patient was requested to elevate the left arm, she was unable to do so as completely as on the opposite side This disability was caused by a strand of tissue which was not only palpable but also visible, which ran in the anterior portion of the axilla from the chest wall toward the humerus and was apparently quite taut The strand of tissue felt about the size and consistency of an adult vas deferens and was rather tender It was about five inches long, these measurements are only approximate because I could not

follow the cord toward the breast quite as readily as in some of the other cases It was distinctly subcutaneous and not intracutaneous I presented the patient to several colleagues One was inclined to doubt my tentative diagnosis and suggested that the strand of tissue palpated might be the tendon of an abnormal slip of the pectoralis major Continuing my examination, I believe I also felt two short cord-like strands in the subcutaneous fat of the anterior abdominal wall, running in a sagittal direction in the nipple line of the left side, but I am not fully convinced that this observation was correct (Fig 7) I have seen the patient several times since and at each examination could verify the correctness of my various observations I suggested an excision of the cord to the patient, being convinced that this procedure would free her from all her complaints, but thus far have failed to gain her consent to an operation

The case just described is exceptionally noteworthy, because we are dealing with two sisters, both of whom show an abnormality in the development of the breast, one sister has bilateral supernumerary axillary breasts while the other sister has an inflamed vestigial mammary structure

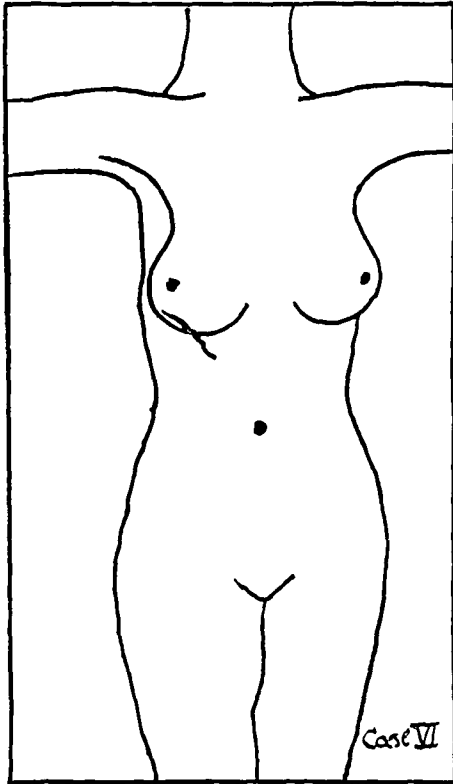


FIG 8—(Case VI) Note short diagonal inframammary cord on right side

CASE VI—December 9, 1932, I was invited by Doctor Brettauer to see Mrs R H, who had consulted him about some uterine trouble She was suffering from dysmenorrhoea and had frequent attacks of mild peritonitis She availed herself of the opportunity to also show Doctor Brettauer a cord-like structure located below the right breast This cord had existed for a number of years and was painful from time to time, particularly during her menstrual periods

On examination, I again found a peculiar cord about two and one-half inches in length which began at the periphery of the right breast, not, however, in the nipple line but a trifle to the right of it (Fig 8), nor did it run in the general direction of the symphysis pubis, but more toward the umbilicus I am therefore not convinced of the correctness of the observation in this case I am inclined to include it, however, for the reason that it presented most of the characteristics of the other cases and also on account of the pain and tenderness in the cord during her menstrual periods Doubt is created in my mind only because of the direction of the cord which was not quite

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as it existed in other cases, namely, toward the symphysis pubis. Doctor Brettauer expects to operate upon this patient for her uterine trouble, at the same time, he intends to excise the cord under discussion for pathological examination.

*Symptomatology*—A careful survey of these six histories reveals a comparative lack of symptoms, those few symptoms that are present, however, are very definite and striking. The outstanding feature of all these patients and the one I wish to particularly emphasize is that each one is an actual and actively complaining patient who seeks relief for a very definite ailment, in other words, the physical signs to be shortly described were not merely accidental findings in otherwise healthy individuals. In the main, the principal complaint of these patients is either pain or functional disability, or both, either below the breast extending for a variable distance upon the abdomen, or above the breast extending towards the corresponding shoulder and axilla. Pain was present in all cases but was rather severe in Cases II, V, and VI. The functional disability, as might be surmised, was more pronounced in the three supramammary cases and was an outstanding feature in Case V. This is just what might have been expected on account of the anatomical location of the lesion, the region of the shoulder, which is much more liable to slight traumatic insults than the soft tissues of the abdominal wall.

*Physical Signs*—The preeminent physical finding is the presence of a cord-like structure in certain characteristic locations and only in these, namely, either upon the abdomen or on the thorax and axilla or both.

The cords are found only in the course of a very narrowly circumscribed line which begins in the lateral part of the axilla and runs towards the chest, upon reaching the chest, the line curves downward to reach the upper border of the breast in the nipple line. This part of the line may therefore be called the supramammary part of the line. The inframammary portion of the line begins at the inferior border of the breast in the nipple-line and runs, slightly converging towards its fellow of the opposite side, in the general direction of the symphysis pubis. (Fig 9)

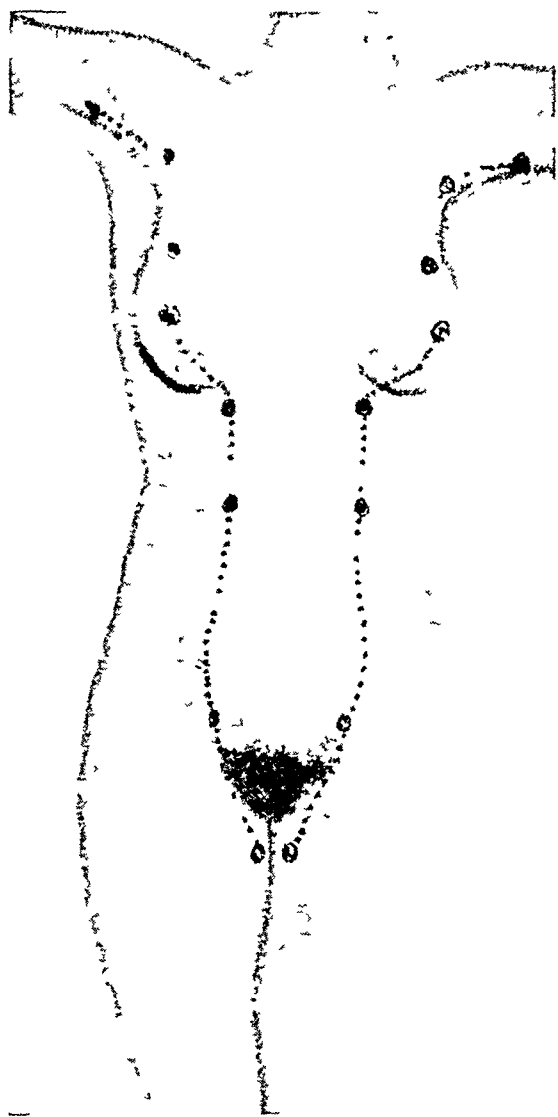


FIG 9—Outline of milkridge after Dietrich and Frangenheim<sup>1</sup> (After Merkel)



The cords vary in length, nor can the length be measured accurately because they tend to fade imperceptibly at both ends into the surrounding tissues. Some of the cords I have observed were very short, not more than two or three inches, while others were quite long, up to eight inches or more. It is not an easy matter to give an accurate description of the cord, the best way I can describe it perhaps, is to compare it to an adult vas deferens, because of the sensation which it imparts to the examining finger. A few of the cords were somewhat thinner than that. During what might be termed the more acute stage of the illness, these cords were quite tender, but with the subsidence of the acute period, the space previously occupied by the cord lacked all tenderness, as might have been expected, as a matter of fact it cannot be differentiated from the surrounding tissues.

The lesion exists in both sexes. Case III was in a male. Apparently, however, it is much more frequent in the female sex, in the six cases reported in this presentation, the ratio was as five to one. I have already indicated that the localization of the cords in question is confined within very narrow limits. I have encountered them on both the right and left sides, always, however, on the anterior surface of the chest and abdomen and never on the back or sides.

If the location, direction in fact entire topography of the line are studied, it becomes evident that there must be some anatomical basis for this peculiar and one might almost say, spectacular distribution, and yet, up to the present time, at least, nothing of the kind has ever been described as existing in post-natal life. In order to find a correct explanation of this peculiar distribution, it is essential that we trace the embryology of the breast.

*Embryology*—The entire embryological development of the breast is interesting. It is not my intention, however to describe it at great length, because only one very brief phase of it, namely, the one that exists only in a fifteen-millimetre embryo is german to the subject under consideration at present. Those interested in the later stages are referred to the masterly monograph by Eggeling<sup>2</sup> which brings the subject practically up to date and has the additional merit of a very complete bibliography. Prior to 1892 our knowledge of the early development of the breast was limited to the stage of the papilla and bud formation, nothing whatever was known of the various preceding stages. In the year 1892, O. Schultze<sup>3</sup> described a much earlier stage in the development of the breast in a series of animals, namely, in pigs, rabbits, cats, foxes and moles. Schultze reports that he saw in a fifteen-millimetre embryo, a line which ran from the attachment of the plate of the anterior extremity to the attachment of the plate of the posterior extremity. He describes the line as being very narrow and as being slightly

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\* This is not quite as self-evident as might be expected, because in some mammals, for instance, in certain members of the hippopotamus group, the normal breast is located not upon the ventral surface of the body, but well over on the side. This is a rather wise provision of nature, as it enables the young, usually carried upon the back of the mother, to suckle even when the mother is partially submerged in water.

† Whenever measurements of embryos are quoted in this article, it always means nape-breech length.

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elevated Schultze called this line "Milchlinie" or milkline, although he adds that "Milchleiste" or milkridge, would perhaps be a more appropriate name. Subsequent writers on this subject are not entirely in accord as to the proper nomenclature, as some speak of a milkline, others of a milkridge and still others use both terms indiscriminately. My knowledge of embryology is too meagre to give me the privilege of taking sides in this controversy. It appears to me reasonable, however, to call the very earliest stage of the structure a milkline ("Milchlinie") and subsequently, when it has attained an appreciable thickness, to call it a milkridge ("Milchleiste").

The next contribution of importance is that of Hugo Schmidt,<sup>1</sup> who, having been interested mainly in the question of supernumerary breasts and nipples, approached the problem from a slightly different angle. Schmidt's article, although quite short, is a very valuable contribution to the question, it is regrettable, however, that his article, owing to many apparently contradictory statements, lacks conviction in some respects. Thus, for instance, if I understand properly a rather involved sentence on p. 702 of his article, he goes so far as to deny even the existence of a milkline. The only saving clause is that he qualifies his negating statement by adding the words, "at least, not to the extent described by him (Schultze)." He examined human embryos of the proper size for the presumed Milchleiste, which had already been discovered by Schultze in pigs and other animals, and definitely states that he failed to find one. In my estimation, no valid reason whatsoever exists for making such a statement because he promptly reverses himself when, in the further course of his description, he states that he saw in the anterior axillary line of two embryos a line running downward for one to two millimetres which was lighter in color and which may have been a Milchleiste.

The two embryos examined by Schmidt were fifteen millimetres long. In the first embryo, he saw a line on the left side under a magnification of seven diameters, it was short and comparatively thick. In the second embryo, it was not quite so distinct, but judging solely by his description, Schmidt must have seen it, because he definitely states that he observed the line divide at one point, and in addition, saw in the line of division an oval area which became more conspicuous because of its darker color.

No such line was to be seen in larger embryos, namely, those of seventeen to thirty-four millimetres.

Schmidt made his most interesting and valuable contributions when he studied his material microscopically. He made serial sections parallel to the long axis of the embryo, which began at the axillary end of the line and progressed towards the midline. In this manner, he discovered in addition to the anlage for the main mammary gland eight other, although smaller anlage, which he designates as supernumerary mammary anlage. The outermost one of these was near the axillary end of the line.

It is rather important to bear in mind that Schmidt made his microscopical sections parallel to the long axis of the embryo, because in this manner he discovered that the additional mammary anlage cephalad to the main mammary anlage were to the outer side of the nipple line, while those situated caudad were internal to the nipple line. Schmidt made, as already stated, his sections parallel to the long axis of the embryo and by subsequent reconstruction he was enabled to map out the peculiar course of the line. The great merit of Schmidt, therefore, is that his contributions laid the foundation of our knowledge of the peculiar topography of the milkline in the human body.

In spite of Schmidt's denial of having seen a macroscopically visible milkline in his embryos, it appears quite conclusive to me that he must have done so. Be that as it may, all subsequent writers on this subject generally give credit to Kallius for having been the first to see a milkline in a human embryo.

Kallius<sup>2</sup> was the first person to see the analogue of Schultze's milkline on a fifteen-millimetre embryo. The cue to it was its lighter color. He stated that on the right

side he saw a ridge-like elevation, which began about 0.25 millimetres below the attachment of the anlage to the upper extremity. It was situated approximately in the mid-axillary line and was about 1.5 millimetres long. As it descended it gradually faded away, and, in consequence, the lower limit of the line was not as sharply demarcated as the upper. The entire width of the line was about one-third millimetre. Kallius furthermore states that he had difficulty in measuring the exact height of the line, but he estimated it to be about 1.5 millimetres. At all events, it was thick enough to cast a shadow when properly illuminated. With negligible variations, the line on the left side was similar to the one on the right.

Microscopically, this ridge-like elevated line proved to be, throughout its entire extent, a distinct thickening of the epidermis, of varying width and depth, and composed of layers of cylindrical cells. Kallius quite justifiably looks upon this even microscopically readily visible line or ridge as the very earliest anlage of the breast. Subsequently, a true breast forms only from a comparatively minute portion of the line and he surmises that the remainder of the line disappears. It is rather interesting to note the importance of the early development of the breast, as Kallius estimates his



FIG 10—Embryo after Kallius,\* right side



FIG 11—Embryo after Kallius\*, left side

embryo to be, at most, thirty to thirty-four days old (Figs 10 and 11). Kallius is of the opinion that, at least in the human embryo, the milkline appears very rapidly and disappears just as rapidly, but he offers no evidence of having actually observed it. His assumption of the disappearance of the human milkline has, however, a rational basis, because a process of a similar nature has been observed in pigs.

Chronologically, the next contribution of importance is that by Heinrich Schmitt,<sup>9</sup> in which he confirms the observations of O. Schultze, Hugo Schmidt and Kallius. He is rather scrupulous in giving Kallius the credit for having discovered the enormous extent of the *Milchleiste*, over such a large surface area of the embryo. Schmitt describes the subsequent development of the breast and finally adds the significant statement that considering the fact that the breast develops only from a comparatively small portion of the *Leiste*, the remaining portion of this embryonal structure must, in the course of further development, undergo retrograde changes. Both Schmitt and Kallius are of the opinion that the long caudal portion of the *Leiste*\* not utilized in the development of the normal breast is very probably the precursor of supernumerary breasts. As a matter of fact, he literally makes the statement that he actually saw occasional structures in older embryos which gave him the impression of a temporary

\* Kallius, as accident will have it, made his observations on a mutilated embryo, the head having been severed in transit. The head shown in outline in his illustration, which accompanies this article (Fig 10), was drawn in subsequently, after comparison with His *Normaltafel*.

hyperthelie Whenever supernumerary breasts and nipples develop, they are always located in the course of the Milchleiste

The last decade of the nineteenth century was peculiarly prolific in articles dealing with the various stages of the development of the breast The majority of these contributions are, in the main, confirmatory of preceding observers, very little is to be gained, therefore, by quoting these at greater length Full meed of credit, however, must be allotted to the truly astonishing observations of Ernst Bresslau<sup>7</sup> who has done perhaps more than anybody else to clarify the comparative embryology of the mammary gland, having studied the subject most carefully and assiduously in the three principal mammalian groups, namely, in the monotremes, marsupials and placentals I want to mention Bresslau's contribution particularly, because in his discussion of the mammary development of bats (who like humans, have only one pair of breasts, namely, pectorals) he states that he saw a Milchleiste in a five-millimetre embryo, the cephalic end of which forms the definite anlage of the breast, and he casually adds the significant remark "that the rest disappears"

Bresslau concludes his article by propounding the hypothesis that the epidermis in those locations where the milkline existed in the embryo never loses its primary inherent property, in consequence of which it always retains the power to proliferate at some future time I cannot fully subscribe to this proposition in the present state of our knowledge In my judgment, it would be rather hazardous to venture an opinion in the question as to whether a supernumerary breast, which is perhaps discovered for the first time at puberty or during lactation, has just been formed or whether it has existed in a dormant and undeveloped stage for a long time, on the contrary, to me, it appears rather probable that the latter is more likely

The numerous articles that have appeared since the epochal discoveries of Schultze and Kallius are in the main casuistic contributions to the subject of hypermastie and hyperthelie Deaver and McFarland,<sup>8</sup> in their monograph on the breast, have compiled a notable series of these and other abnormalities of the breast These authors deserve the greatest credit for a monumental work

To recapitulate, we may accept as proven

(1) There exists in embryonic life (seen in fifteen-millimetre embryos and in a few instances in even smaller embryos) a line which is the earliest anlage of the breast

(2) This line has a very definite localization Roughly speaking, it extends from the axilla to the symphysis pubis

(3) Although this primitive line is very long, a true breast in the human species develops only at one point, namely, in the pectoral region

(4) When abnormalities occur, *e g*, hypermastie or hyperthelie, these abnormal structures are always located in the course of this line The very rare exceptions reported as having been encountered in other parts of the body lack all acceptable scientific proof

(5) There are only surmises as to what becomes of that apparently superfluous part of the line which does not enter into the formation of the breast Most authors do not discuss this phase of the subject at all A few, for instance, Lustig<sup>9</sup> or Heinrich Schmitt,<sup>6</sup> mention only casually that the milkridge regresses or that it disappears, but no one brings proof of having actually observed it

O Schultze, in his discussion of the development of the breast in animals, ventures a little further, at least, he states that at a certain stage there begins a resorption of that part of the milkline which exists between primitive tits.†

(6) Finally, up to the present time at least, no one has observed a persistence of the milkline or any part of it in post-natal life

Since becoming interested in this subject, I have had the good fortune to observe six cases of what I consider to be persisting milklines, so altered

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\*Why not also the cephalic portion?

† Not to be confounded with the ultimate teats

pathologically as to be recognizable by simple palpation. The question quite naturally suggested itself to me as to the frequency of the persistence of shorter or longer portions of the milkridge in human beings which are not changed pathologically and which, in consequence, escape all detection. For aught anybody knows, it may be a very common occurrence or perhaps it exists undetected in most individuals like many another vestigial structure, for instance, the organ of Rosenmüller or the hydatids of Morgagni. I have discussed this problem with anatomists and have even suggested investigation of the subject. Such an investigation, I have been advised, would entail an amount of labor and expense which does not appear warranted for the time being.

If we now recapitulate my clinical and scanty pathological observations and correlate these with the present-day accepted knowledge of the embryology of the breast, we must inevitably arrive at the following conclusions:

(1) There exists in certain individuals an abnormal persistence of the milkridge in some part of its normal course.

(2) Such a persisting milkridge is absolutely symptomless and is therefore not discoverable.

(3) For some reason or other, this abnormally persisting line may become changed pathologically (I presume inflamed, judging from the one section I have been able to study) and it then gives rise to the various symptoms and physical signs I have enumerated in another portion of this paper, in consequence of which it becomes discoverable.

(4) Finally, one must also arrive at the conclusion that if the lesion were discoverable or had actually been discovered, it has not been hitherto recognized.

Just a few words in explanation of the name "Vestigial Mastitis." I have searched for a name which would be both descriptive and accurate. The disease in the present state of our knowledge is some kind of pathological process, let us say inflammatory, in a vestigial structure. Strictly speaking it is not a mastitis, and yet the cells which enter into the formation of the structure are so much akin to mammary epithelial cells that the word mastitis appears to be justified. I am indebted to Dr. Howard Lilienthal for the excellent suggestion of a descriptive name.

A word of apology for the paucity of the pathological material submitted by me in confirmation of this thesis. I have done my utmost to persuade more patients to consent to operation, but, as is evident, I have not been very successful. At the same time, the one case which was examined pathologically is, to my mind, so conclusive that it goes very far in confirmation of my theory.

I am sure it does not require more than passing mention that I have searched the surgical literature very thoroughly for reports of similar cases and that I have failed to find anything even remotely suggestive.

At the conclusion of my presentation, I wish to express surprise that this practically superficial lesion has escaped all notice up to now. This cer-

## VESTIGIAL MASTITIS

tainly has been my experience in a rather active surgical career of many years

I have been much interested in this subject during the past three years, and now that I have called attention to it I trust that my findings will be confirmed by future observers

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DISCUSSION—DR HOWARD LILIENTHAL (New York City) said that he had one patient who had this peculiar vas deferens feeling in the arm just anterior to the axilla. He thought it was lymphangitis. He sent her to Mt Sinai Hospital in the ward service where a small adenofibroma was excised. The vestigial mastitis disappeared and they lost the opportunity to investigate it.

He believed that this diseased condition exists oftener than surgeons have any idea of. Of course, the embryonal tissue probably exists frequently but inflammation must be present before one can feel it objectively. Biopsies should be more often made.

He said Doctor Moschcowitz seems to have revealed his anxiety to get the specimen more than he should have, or the patient would have consented. If he had told her he didn't know what the disease was, and that it was important to make a diagnosis, he might have had a chance to excise the specimen.

Anything one cannot recognize and diagnose ought to be investigated. It is perfectly proper to inform the patient and make him—or her—understand the importance of diagnosing with accuracy.

DR EDWIN BEER (New York City) said that he had seen one of these cases in Doctor Moschcowitz's office. This is a new clinical entity and according to the comparative anatomist there is a very definite anlage from which these various structures may develop. Whether it is a frequent occurrence or not, or whether one finds such cases, as so often happens, after looking carefully, he did not know.

Yet so many new clinical entities have been described in the last thirty years—entities which had not been recognized—that this type of mastitis might belong to the same group.

DR ALEXIS V MOSCHCOWITZ (New York City) said he had been working on this subject for the past two or three years. The hard part is that here is a lesion which is absolutely superficial. It is subcutaneous. One can feel it and palpitate it. If one is on the lookout for it he was sure one would find it.

With regard to the pathology, in order to be absolutely certain, he sent the sections abroad and they had them examined by Professor Pick in the University of Berlin. He absolutely agreed with his findings.

## SKELETAL PATHOLOGY OF ENDOCRINE ORIGIN

BY MAX BALLIN, M D

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THE connection respectively between calcium phosphorus metabolism and parathyroid pathology is well established by many post-mortem findings of osteomalacia coincident with parathyroid tumors, by the now frequently repeated experimental production of osteomalacic symptoms, especially *ostitis fibrosa cystica generalisata* (the main skeletal change in parathyroidism), by the injection of large amounts of parathyroid hormone, and last but not least, by the cure of such osseous softening which follow the surgical removal of parathyroid tumors (hyperplasias or adenomata) With this new information on parathyroid pathology and the knowledge of the connection between islet tumors and hyperinsulinism, between adrenal tumors and paroxysmal hypertension, between basophile adenomas of the pituitary and plethoric adiposity (Cushing's syndrome), *etc, etc*, it seems at times that this fascinating study of the endocrine glands now offers a definite understanding of their function But then again so many observations contrary to this seemingly acceptable physiology of the endocrines appears that the present knowledge after all is still unsatisfactory The main factors clouding the question are the interrelation of functions and the substitution of one gland for another in temporary or lasting deficiencies, polyglandular upsets existing with or following the breakdown of one type of glands Perhaps, also, the governing influence of pituitary hormones on the function of the other endocrines, as has been proven by experiments and clinical observations, is such a factor in rendering the endocrine functions hard to understand In the gross physiology of endocrine glands the following data are outstanding enough to be acceptable according to our present knowledge

(1) The thyroid is in control of basal metabolic rate, combustion of carbohydrates, fats and proteids (the last still doubtful)

(2) The parathyroids are in control of calcium and phosphorus metabolism

(3) The pancreatic islets are in control of sugar metabolism

(4) The pituitary is in control of growth, fat, pigment, sexual development, *etc*

(5) The adrenals are in control of blood-pressure, muscular tonicity, *etc*

This tabulation suffices for a few classical cases in each group, but then we hear of diabetes of thyroid or pituitary or renal origin without apparent pathology in the islets, of an upset in calcium without any parathyroid pathology or of symptoms partially thyroid, partially adrenal in character Recently an important article by Wilder<sup>20</sup> treats of "Polyglandular Dyscrasias Involving Abnormalities of Sexual Characteristics" The title

## ENDOCRINE SKELETAL PATHOLOGY

could just as well have read "Polyglandular Dyscrasias Involving Abnormalities of the Skeleton," as it will be impossible to separate, for instance, the sexual symptoms and the osseous symptoms in polyglandular upsets. There are always several rows of outstanding symptoms. Our discussion will concern upsets in calcium and phosphorus metabolism, in other words, skeletal changes caused by endocrine disturbances. Obviously, here also other symptoms have to be brought in if for no other reason than for differential diagnosis. To be sure, the parathyroid undoubtedly is responsible for most of the endocrine skeletal changes, but a good many cases are now known of skeletal changes in other endocrine conditions that a classification as to their differentiation seems to be desirable. It will be difficult to limit this discussion to processes plainly endocrine in origin, a few metabolic disturbances are closely related to endocrinopathy without any endocrine connection being known so far.

Besides, (1) parathyroidism, we will consider skeletal disturbance in (2) thyroidism, (3) and (4) thymus and pituitary pathology, (5) after loss of ovarian function, *etc.*, (6) pancreatic and suprarenal polyglandular syndromes, (7) xanthomatosis (lipoid upsets), (8) renal rickets, leukæmic and splenic conditions and biliary fistulas.

### *A Skeletal Disorders Due to Faulty Nutrition*

#### AVITAMINOSIS

	Main Symptoms	Gen or Local	Pathology	Serum		Etiology	Para-thyroid	Treatment
				Ca	P			
(1) Rickets Infantile	Deficient calcification of osteoid tissue during ossification	General	Decalcification irregular endochondral ossification Tetany rare	8 Rarely 6	2 Low	Food deficiency and avitaminosis	Hyperplastic functional adaptation	Dietary Vitamines Calcium Light
(2) Osteomalacia Adult	Deficient calcification of osteoid tissue after ossification	General	Decalcification Tetany frequent	5 to 7	1.8 to 3.5	Food deficiency and avitaminosis starvation, pregnancy	Hyperplastic functional adaptation	Dietary Vitamines Calcium Light

Before entering the discussion of the purely endocrine disorders the skeletal dyscrasias due to faulty nutrition, avitaminosis, and so forth will be briefly mentioned, as they are closely related. The differential points are as follows:

(1) Rickets is an attribute of the growing age, usually of infancy, less of adolescence. The affection is nearly always general throughout the whole skeleton and especially affects the growing epiphyseal lines where growth and calcification mainly take place. Serum calcium and phosphorus are but little altered and if so moderately diminished.

(2) Osteomalacia is but an adult type of rickets following faulty nutrition, hunger as in war times, and deficiency in vitamins due to inability to



get properly proportioned foods, this is more harmful when an increased demand for calcium production exists, as in pregnancy

Dietary measures will usually cure rickets and osteomalacias (proper food, vitamins, light, *etc* ) in so short a time that such feeding and treatment may be used as a therapeutic test in doubtful cases The enlargement

of the parathyroid present in rickets and osteomalacia is a compensatory one, the glands become hyperplastic in order to meet the greater demand for their hormone so important for proper calcium and phosphorus metabolism As the compensatory goitre of puberty becomes permanent at times under endemic and hereditary influences, this compensatory parathyroidism in rickets and osteomalacia at times also leads to permanent parathyroidism

(1) *Parathyroidal* osteomalacic changes are the most outspoken of endocrine osteopathies Cases of parathyroid adenomas or hyperplasias with changes in the bones are now so frequently described that the entity is well established One hundred and fifty to two hundred cases are mentioned in the literature of the removal of such tumors or hyperplastic glands with an influence from improvement to clinical cure Under the influence of increased parathormone production calcium is liberated from the skeleton, hypercalcaemia and skeletal decalcification ensue The main osseous alterations of parathyroid origin are general and



FIG 1—Progressed case of parathyroidism Note decalcification of skull with disappearance of bony limits, giant cell tumors (osteoclastomas) in long bones (Max Ballin and P F Morse, Amer Jour Surg vol xii No 3, pp 403 416 June, 1931 ) For other instances of parathyroidal skeletal pathology see Fig 5

localized decalcifications In the general type the bones look as if they were underexposed, in the roentgenogram in extreme cases the bony limits are dimmed, but nearly always this general deficiency of calcium is accompanied by localized fibrocystic areas These areas are sometimes minute, giving, for instance, to the skull a general granular mottled appearance In other cases

larger cystic areas form containing osteoclastomatous, giant-cell tissue, deformities, curvature of the long bones, compression of the vertebræ and fractures follow so that we have a very characteristic picture of a parathyroid osteitis, or osteosis as Lièvre<sup>15</sup> calls it (in order to avoid giving the impression of any inflammatory process he prefers osteosis to osteitis)

At the same time the changes in the blood calcium are more or less pronounced, the serum calcium being increased from a normal of eight to ten milligrams per 100 cubic centimetres up to twelve and even twenty-three milligrams. The normal serum phosphorus of three to four milligrams falls to two to one milligrams and less. Muscular weakness, calcinuria, metastatic calcium deposits, and so forth, are other symptoms of this special osteomalacic type. There are enough characteristic symptoms so that a diagnosis may be positively made in a great majority of cases (Fig 1)

*B Skeletal Disorders Due to Endocrine Pathology*

I PARATHYROIDISM

Main Symptoms	Gen or Local	Pathology	Serum		Etiology	Para-thyroid	Treatment
			Ca	P			
General decalcification, osteitis fibrosa cystica with localized cystic or osteoclastomatous areas, deformities, fractures	General and localized	Osteitis fibrosa cystica giant-cell tumors and cysts in bones. Adenomas and hyperplasia of parathyroid	12 to 23	0.6 to 3	Hyperfunction of parathyroid due to adenomas or hyperplasia of gland	Adenomatous or hyperplastic	Parathyroidectomy (radiation) and medical care as indicated (calcium vitamin D, etc)

(2) *Thyroidism* is accompanied by markedly increased calcium excretion (Aub, Bauer, Heath and Roper<sup>1</sup>). This increase in the elimination of calcium has been reported in one case 231 per cent above normal, in another case eight times normal values were reported. The same increase in calcium excretion may be produced experimentally by feeding thyroid extract and this increased excretion of calcium returns to normal if the patient or experimental animal is treated with Lugol's solution or if the exophthalmic goitre is removed. In toxic adenomas the calcium excretion is not as much increased as in exophthalmic goitre, but the increase may go up to twice normal values, likewise returns to normal with removal of the adenomatous goitre. In myxœdema, the opposite, the calcium excretion is diminished (the thyroid treatment of tetany is based on this observation).

In spite of the increased calcium excretion in thyroidism there is no hypercalcæmia present as in parathyroidism and this is an important distinguishing factor. In the thyroid type the increased calcium excretion is urinary and fecal. The phosphorus also takes part in this increase. Kummer<sup>14</sup> has shown this increase of calcium excretion in exophthalmic goitre accompanied by marked decalcification of the skeleton, but this osteoporosis in thyroidism is a general one in opposition to the lacunar resorption in parathyroidism leading to the peculiar mottled appearance of the bone, in

pathological terms to osteitis fibrosa cystica. The general decalcification in exophthalmic goitre is rarely complicated by a mild lacunar resorption and then we probably have to think of a combination of thyroid and parathyroid disturbance (Fig 2 A, B, C)

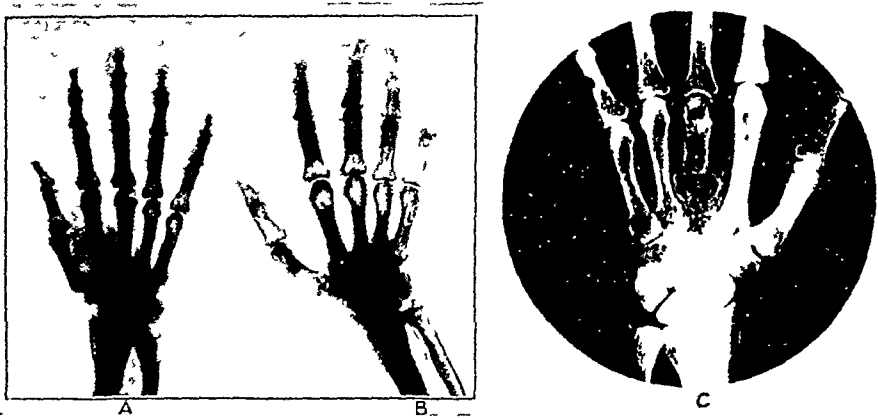


FIG 2—Note the plain osteoporosis in exophthalmic goitre (B) compared with the calcification of a normal hand under the same exposure (A), versus a hand in a case of parathyroidism with localized rarefaction and giant cell tumor (C)

### B Skeletal Disorders Due to Endocrine Pathology

#### 2 THYROIDISM

Main Symptoms	Gen or Local	Pathology	Serum Ca P	Etiology	Parathyroid	Treatment
General decalcification (with only slight lacunar resorption)	Mostly general Very few localized areas	Goitre adenomatous or hyperplastic thyroid Decalcification of bones (no osteitis fibrosa cystica)	Normal, no increase in spite of increased excretion of both	Thyroidism causing increased Ca and P elimination 2-8 times normal amount in faeces and urine due to high B M R	No changes but adenomatous processes are not infrequent in both thyroid and parathyroid	For thyroidism (surgical radiation medical)

(3) *Thymus* (Fig 3)—The thymus was for a long time considered as mainly responsible for rachitic and osteomalacic processes. Klose,<sup>13</sup> Matti and others described such changes after experimental removal of the thymus, irregularities of the epiphyseal zones, thickening and widening of epiphyseal cartilages, followed by compression of the cartilaginous area, osteoid tissue filling the narrow cavities, thinning the cortical substance and spontaneous fractures occurred. Other investigators could not confirm these experiments (R D McClure<sup>16</sup>) and the importance of the thymus in these processes was doubted. We have operated on children with osteochondritic and fibrocystic changes around the epiphyseal lines resembling parathyroidism, and in three patients we found large thymus remnants in the lower deep cervical triangles. Hyperplastic parathyroids were encountered besides the thymus in one of these three cases. The large thymus, three by two centimetres, was resected. The results of these operations we will discuss at some future time after longer observation. It seems to us so far that there is some connection,

## ENDOCRINE SKELETAL PATHOLOGY

besides the well-known embryological relation of thymus and parathyroid, and that in children at least some relation of function exists also influencing bony growth Bergstrand<sup>4</sup> has extensively written of the thymus-parathyroid



FIG 3—Tumor of thymus and parathyroid (girl of six years) Osteitis fibrosa cystica of femur, skull Fracture through cystic area, coxa vara A definite compact hyperplastic parathyroid and a large hyperplastic thymic nodule with many Hassall's corpuscles, some of them calcified without oxyphile cells, were removed Decided improvement In one other similar case only a thymus tumor was found

combination We have found a very large thymus also in a seven-year-old boy with typical osteogenesis imperfecta

(4) *Pituitary Skeletal Changes*—Since Pierre Marie's work on the pituitary origin of acromegaly, the acromegalic skeletal changes with pituitary tumors have been known More recently a group of changes has been observed in another pituitary syndrome In modern pituitary pathology dis-

inctions are made between the symptoms produced by the anterior and posterior lobes and also between the different cell groups, the chromophobe and the chromophile, and in the latter case the acidophile and basophile groups. From a functional point of view a distinction between hypo- and hyperpituitarism is also made. Erdheim,<sup>8</sup> Berblinger<sup>3</sup> and, in our country, the lucidly written essays of Harvey Cushing<sup>7</sup> have contributed to the understanding of this chapter. For our purposes it will be sufficient if we take up the skeletal disorders: (a) those due to chromophobe adenomas of the anterior lobe of the pituitary, under which group acromegaly is the prominent representative, and (b) the basophile adenomas of which basophilism, by some now called Cushing's syndrome, is the main clinical entity.

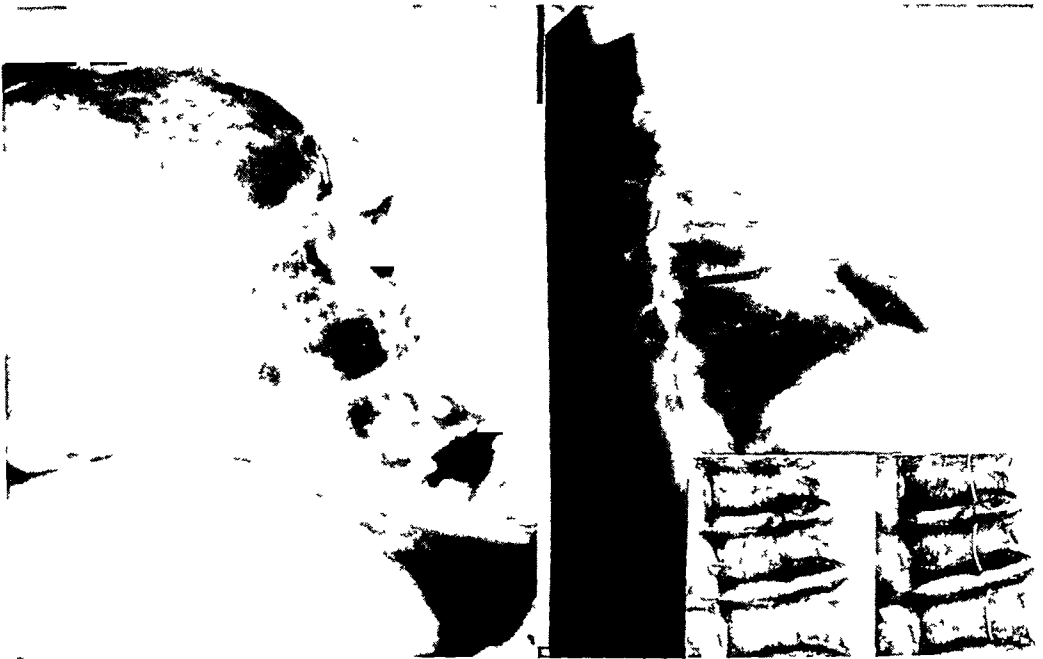


FIG. 4.—Acromegalic skull and spine. Note immense jaw and supra orbital ridge in temporo parietal region, some fibrocystic changes as in parathyroidism. The vertebræ are flattened. Insert (from Erdheim<sup>8</sup>) shows the periosteal new bony addition to the vertebral bodies. The white line shows the limit between the original body and the acromegalic addition. At autopsy, a large hemorrhagic cystadenoma of the anterior pituitary lobe, also a suprarenal adenoma, were found.

The skeletal changes in acromegaly (a) are hyperostosis of the skull, clubbing of the phalangeal ends and periosteal thickening of the vertebral bodies. The spines of such patients show kyphosis and a flattening of the vertebræ anteriorly so that they resemble grossly the spine in parathyroidism with this compression of the bodies. In acromegaly, however, the vertebræ show new bone formation entirely different from that seen in parathyroidism. The acromegalic vertebræ show anteriorly new bone forming, always distinguishable from the old part of the vertebræ by a demarcating line. No such new formation takes place in parathyroidism where the bone simply collapses from lack of lime (compression fractures), whereas the acromegalic vertebra is flattened and broadened and increased, especially anteriorly, in the circumference of the body by the newly formed, though less weight-

## ENDOCRINE SKELETAL PATHOLOGY

bearing bone (Fig 4) Furthermore, the acromegalic bone changes are accompanied by increase in the size of the hands, feet, jaw and frontal supra-orbital ridges and this growth is not limited to the bones alone but also affects the soft parts, thus placing the acromegalic skeleton in a class by itself

The serum calcium is usually normal, although in one of our late cases we have seen a calcium of 12.6 milligrams, but autopsy in this case, as so frequently, showed polyglandular changes, small adenomas and hyperplasias of the parathyroids and an adrenal adenoma. In a pure case of acromegaly there seemed to be no changes in the serum calcium and serum phosphorus

### *B Skeletal Disorders Due to Endocrine Pathology*

#### 3 PITUITARISM

##### (a) Chromophobe (b) Basophile Adenoma (Cushing's Syndrome)

Main Symptoms	Gen or Local	Pathology	Serum		Etiology	Para-thyroid	Treat-ment
			Ca	P			
(a) Acromegaly Giantism	General and local	Hyperostosis of skull, clubbed phalangeal ends, periosteal thickening of vertebral bodies etc	Normal or slight increase	2.7 mgs	Chromophobe adenomas of anterior lobe of pituitary	Secondary adenomas or hyperplasias	Surgical
(b) Basophilism, hypertension, acrocyanosis, adiposity face neck and trunk striæ decalcification, kyphosis etc	General and local	Basophile adenomas of anterior lobe pituitary Secondary osteitis fibrosa cystica of skull, vertebrae, etc	9.8 to 12.6 mgs	Normal Greatly increased calcium output 840 in 24 hrs urine (vs 186 normal) Increased cholesterol to 250 (vs 180 normal)	Basophile adenomas secondary hyperplasias in thyroid islets and parathyroid		Radiation of pituitary gland

In the second group (b) of pituitary disorders, the basophile adenoma of the anterior lobe of the gland, Cushing<sup>7</sup> has collected fifteen cases, some of his own and some from the literature, and in these decalcification and osteoporosis were shown in the X-ray six times, thoracic kyphosis, loss of height twice, spontaneous fractures in two cases. At post-mortem examination osteoporosis, especially of the spine, was reported six times, whereas in two post-mortems no reference has been made to the skeleton. The calcium in these cases is mentioned twice, once where it was 9.8 milligrams and once a reading of 12.6 milligrams. The calcium output, however, was greatly increased, being reported once six times normal in twenty-four hours urine, that is, 840 milligrams vs a normal of 186 milligrams. A simultaneous increase of cholesterol to 250 milligrams vs 180 milligrams normal seems to be characteristic only for the basophile adenoma and not for parathyroidism.

From these statistics of findings of osteoporosis, scoliosis, spontaneous fractures and loss of height it is evident that the group may resemble that of parathyroidism. The distinguishing features, however, will always pro-

tect against any mistakes in diagnosis. The general symptom complex of the basophile adenoma includes such outstanding symptoms as the hypertension, frequently a hypercythæmia of six million reds and more, an acrocyanosis, the most peculiar (buffalo type of) adiposity limited to neck, face and trunk, not affecting the extremities, the peculiar pigmented striae on the abdomen will always be outstanding. Again, in this chapter of basophile adenomas the autopsies have frequently shown secondary hyperplasia and even adenomas of the parathyroids and other endocrine glands, these possibly being the producers of the skeletal symptoms and the increased calcium excretion.

(5) *Skeletal Changes Following Early Surgical Menopause* (Loss of Ovarian Function)—In the basophile type of adenomas an outstanding symptom is amenorrhœa occurring at twenty or thirty years of age, the favorite time for the starting of basophilism, but this amenorrhœa without any doubt is caused by interference with the sexual function of the pituitary. Another connection between early surgical menopause and decalcification of the skeleton, we could even say with real parathyroid changes of the skeleton, seems to be evident from our material. Of eighteen women with different types of parathyroidism, proven by X-ray, chemical changes and symptomatology, six had early menopause. For instance

CASE I—Mrs J C M, at twenty-five years, had an extensive myomectomy after which she flowed only very scantily for two years more. She had broken her hip at seventeen years, had no trouble, it healed well. After the myomectomy new pain ensued in the hip and X-ray showed a large process of osteitis fibrosa cystica taking in the whole upper part of the left femur and the whole left ilium and acetabulum. Blood calcium was over twelve milligrams. Removal of a parathyroid adenoma gave complete relief.

CASE II—Mrs H G, on account of pelvic inflammatory disease, had both tubes, right ovary and most of the left ovary removed. This was at the age of thirty-two years. She menstruated very scantily up to the age of thirty-six, then ceased entirely. She had severe backaches, X-ray showed decalcified spine with wedging of the vertebral bodies, exostosis of the vertebræ and a blood calcium of 11.2 to 12 milligrams. A small parathyroid adenoma was removed with great relief.

CASE III—Miss J A B had a radical pelvic operation performed for a pelvic inflammatory at the age of thirty-four years with cessation of menses. At the age of forty-four years frequent falls and several fractures occurred, severe hypotonia of the muscles ensued, the legs would not carry this heavy woman of two hundred pounds any longer. The serum calcium was 12.8 milligrams. The roentgenogram of her spine showed compressed vertebræ and large metastatic calcium deposits in the intervertebral discs. Parathyroidectomy gave complete relief.

CASE IV—Mrs M R R had, at thirty years a pelvic operation for inflammatory disease. Menstruation practically ceased after this. At forty-eight years she became very heavy. At forty-five years she had backache, at forty-eight she had a vertebral fracture from a slight cause. This led to thorough examination and several compression fractures of the vertebræ, osteitis fibrosa cystica of the skull, and so on, were found. A parathyroid adenoma was removed with relief of the pain and her symptoms. (Fig 5)

We could repeat practically the same history several times more if we included our newer cases. This coincidence is, therefore, so frequent in

our female patients with parathyroidism that attention should be called to it. While they all had hyperplastic or adenomatous parathyroids, it seems from their records that in nearly every one of them the early post-operative menopause started the symptoms of parathyroidism.

(6) *Suprarenal Gland, Pancreas and Polyglandular Syndromes*—Wilder<sup>20</sup> published four cases of "polyglandular dyscrasias." The first one is a case which, since



FIG 5 —*Parathyroidism*. First symptoms appeared after early surgical menopause. Note compression of several vertebral bodies (retouched), de-  
calcification and formation of nucleus pulposus. Serum calcium thirteen  
milligrams. Hypotonia. Great improvement following parathyroidectomy.

Cushing's communication on basophile adenomas, should be placed under the heading of basophilism, "bearded ladies," and so forth. Besides the hirsutism, the pigmented striæ on the abdomen, the adiposity and hypertension, she had an osteoporosis of the skull and spine and multiple pathological fractures of the lower ribs with extensive callus formation. She was operated upon for suprarenal tumor but only a microscopical adenoma was found in the left suprarenal. She was treated after with Rontgen-ray for the pituitary tumor.

His second case was considered an adrenal tumor. She had the same symptoms of



adiposity around the trunk, high blood-pressure and muscular weakness. The X-ray showed osteoporosis of the spinal column with compression fracture of the eleventh thoracic vertebra, osteoporosis of the pelvis, femurs and skull. There was increased cholesterol in the blood. Both suprarenals were exposed for tumors but none found.

CASE V—(Wilder<sup>20</sup>) Again a woman thirty years old with hirsutism, weakness, amenorrhœa, extreme muscular weakness nearly resembling muscular paralysis of the legs without neurological symptoms pointing to any local or systemic neurological affection. There was also glycosuria. At death a cancer of the *pancreas* was found, no tumor of the suprarenal gland, however. The roentgenological study showed slight osteoporosis of the spinal column, ribs, pelvis and femurs and calcified mesenteric glands.

A sixth case (Wilder<sup>20</sup>) concerns a woman thirty-four years old with amenorrhœa at thirty-two years, who was stout, had facial hirsutism, was round-shouldered, failed in health, had weakness of the legs, trunk obesity and hypertension. Rontgenogram showed osteoporosis of thoracic and lumbar vertebræ with compression of the sixth thoracic vertebra. There was a slightly toxic adenomatous goitre removed previously, great weakness of legs. An autopsy on this woman showed normal pituitary gland, both *suprarenals* enlarged and hyperplastic, combined weight forty-nine grams, a thymus tumor about five centimetres in diameter, an *abscess in the pancreas*, a multiple colloid adenomatous tumor, friable ribs breaking between the fingers.

Dr F W Hartman,<sup>21</sup> of the Ford Hospital, mentioned, in discussing a paper on parathyroidism before a local society, an autopsy showing extensive osteomalacia of the skeleton with a progressed sclerosis of the pancreas. He kindly allowed me to use the following notes on the case: "Thirty-five-year-old man, first seen in 1921, in the following two years developed a picture resembling Paget's disease, lost two inches in height, legs became curved, calcium ranged from 9 to 16.5 milligrams, phosphorous two to three milligrams. Biopsy of bones in 1924 showed osteitis fibrosa cystica. Fracture of right femur in 1926 while sneezing. He died in 1927. The findings at the very minutely carried out autopsy were: Skeleton very soft, extensive osteitis fibrosa cystica, irregular cyst formations around the fracture in the femur, thyroid nothing abnormal, no abnormality in a piece of parathyroid attached to the thyroid, pancreas shows a very unusual picture, smaller than normal, very firm, pale, scarred appearance, cutting with a rasping sound and gritty resistance felt throughout, the lobular markings have disappeared, irregular cystic dilatation in the otherwise fibrous organ. Microscopically chronic fibrous pancreatitis with some intact islets. Chronic nephritis with retention cysts, in the right kidney a minute adenoma, seven by five millimeters (microscopically benign). Thymus, nothing abnormal. Adrenals, 'nothing worthy of special note'. Pituitary, anterior and posterior parts usual cellular appearance, in the intermediate part numerous acinar structures with colloid material. Incidentally, some encysted trichinæ in muscles." The outstanding finding in this case is certainly the chronic fibrous pancreatitis with extensive general osteitis fibrosa cystica.

It is evident from these descriptions that in the case of pituitary basophilism (less in acromegaly), in pathology of the pancreas (a cancer in Wilder's third case, an abscess in his fourth case), in adrenal tumors similar symptoms of polyglandular upsets seem to be frequent.

(7) *Xanthomatosis* (Schuller<sup>18</sup>-Christian<sup>5</sup> Syndrome) —The peculiar complex of symptoms usually called Schuller-Christian disease or disturbance of the lipid metabolism, which was described by Hand twenty years before Schuller,<sup>18</sup> has not been classified generally as an endocrine disturbance, still, Schuller was inclined to consider it a "dyspituitarism". On account of the prevalence of osseous symptoms it deserves to be mentioned here. Schuller called attention to sharply defined "geographical defects"

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in the skull Christian<sup>5</sup> outlined the symptom complex as consisting of defects of the membranous bones, diabetes insipidus and exophthalmos Rowland,<sup>17</sup> of Detroit, collected much material with three cases of his own and thought that the osseous defects, the dyspituitarism and exophthalmos had one common feature, that is, the formation of xanthomatous tissue Xanthomatosis is a local manifestation of this disease and brings it also in contact with Gaucher and Niemann-Pick disease In this unit, for some reason or another, most likely endocrine, an overproduction of lipid substance occurs, a hyperlipæmia, this fat is deposited and stored mainly in the reticulo-endothelial system, the etiological factor is not located in this system Anyway, the deposit of xanthomatous tissue causes exophthalmos through great deposits back of the eyeball and in the dura It seems that such deposits pos-

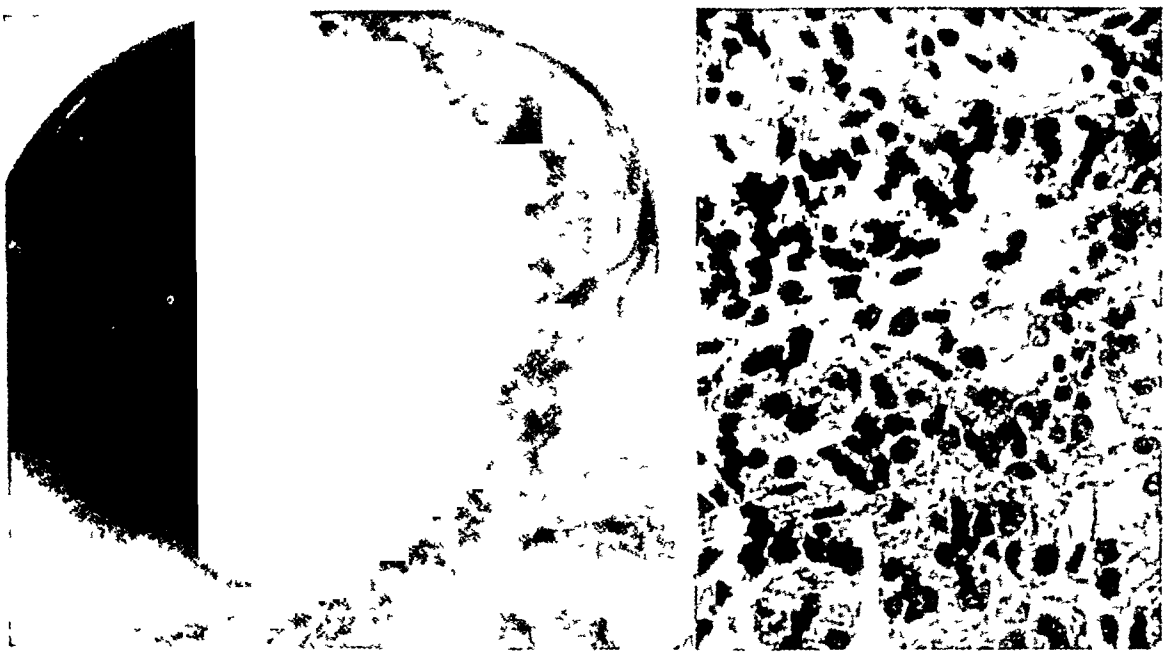


FIG 6—Xanthomatosis (lipoid dystrophy) (1) Bone defects in the skull ("geographical" in shape), such defects being practically limited to the membranous bones (2) Defects are caused by lipid (foam) cells and foreign body giant cells arising from dural plaques (Through kindness of Dr R S Rowland, Detroit, Mich)

terior to the pituitary in the region of the hypothalamus and the pineal body may have a good deal to do with the production of the pituitary symptoms, especially the diabetes insipidus The skull defects in this special group are large, measuring up to five and six centimetres and more in diameter, irregular-like geographical maps They are seemingly produced simply by the pressure of the xanthomatous tissue growing on the dura (just like an aneurysm would erode the bone) or the substitution of osseous by lipid tissue

The calcium and phosphorus are not changed Cholesterol, however, and fatty acids are very much increased in the blood-serum Cholesterol seems to be the fat most deposited in the Schuller-Christian disease, whereas in Niemann-Pick disease and in Gaucher's splenomegaly lecithin-like fats prevail

Figure 6 shows how these defects, by their size and irregularity and by

being confined to membranous bones, differ from the small granular or larger cyst-like defects in parathyroidism, also the complicating diabetes insipidus, fibrosis of the lungs following xanthomatosis of the lungs, all these symptoms obviously make the differentiation between Schuller-Christian syndrome and parathyroidism very easy. The treatment of the group, since we do not know for certain the actual cause, is symptomatic and Rowland<sup>17</sup> reports results in early cases by giving a diet to prevent the hyperlipæmia.

(8) *Decalcification in Renal Rickets, in Splenomegaly with Hæmolytic Icterus and in Complete Absence of Bile from the Intestines*—This chapter is mentioned incidentally for its similarity in findings without any attempt at present to refer it to an endocrine cause.

*Renal rickets* is characterized by nephritis and most severe osteomalacia. In a case observed the bones could be cut at autopsy with an ordinary knife just as in a very progressed case of parathyroidal osteomalacia. At the same time the kidneys were entirely atrophied, small, about one-sixth the normal size. There was also a large parathyroidal adenoma. This same observation has been made by different observers, that is, the combination of the peculiar renal atrophy with parathyroid tumor. An outstanding clinical symptom in renal pathology is very high serum phosphorus going up to five milligrams and even more. This seems to be a symptom singular to this affection. The bones can hardly be distinguished from those in progressed parathyroidal osteitis fibrosa cystica and the relatively frequently found parathyroid tumor still more suggests some relationship. It suggests itself that the affection of renal rickets existing early in life may be due to a shrinking of the kidney following hypercalcæmia as it is known in the usual case of parathyroidism. Still, the pathological findings in these atrophied kidneys seem to speak more for a primary nephritic process or a congenital deficiency of the kidney leading secondarily to a high phosphatæmia and the osteomalacic changes.

Still weaker in reason for being classified with endocrine disturbances is the entity of *anæmia* in children with *splenomegaly* and peculiar changes in the bones. This is a syndrome now described quite frequently under different names, occurring early in life, during the first two years, characterized by a hæmolytic anæmia possibly due to a defect in the hæmopoietic system, the blood-picture being characterized by a great number of immature forms, leucocytes and changes in the bones. Icterus seems to be prevalent also in this group. The peculiar bone changes as expressed suggest that for differential diagnostic study the affection deserves to be mentioned here.

A good deal of experimental work has been done besides a few clinical observations in *complete bile fistulas* showing that absence of bile from the intestinal tract leads to osteoporosis, softening of bones and spontaneous fractures (Pavlov, Wisner and Whipple, Emerson, J. D. Greaves and Carl L. A. Schmidt<sup>9</sup>). It is most interesting that even the smallest amount of bile in the intestinal tract under such conditions will prevent these osteomalacic processes. Therefore, it seems the suggestion may be correct that in the absence of bile vitamin D is not absorbed, otherwise, it is hard to understand why the presence of a very small amount of bile in the intestine would

prevent the osteomalacias. Animal experiments have shown that in dogs where a bile fistula was established, usually by connecting the gall-bladder with the pelvis of a kidney (cholecystonephrostomy), on a known calcium intake a negative calcium and phosphorus balance was present, the administration of viosterol would make this balance again positive. The similarity between the non-absorption of vitamin D in parathyroidism and also in bile fistulas warrants mentioning this osteomalacia even if at first it is seemingly just an avitaminosis.

*Conclusions*—Classical osseous changes in endocrine disease are caused by parathyroidism, but also in thyroidism we find decalcification, immense new formations in bones are encountered in acromegaly, whereas in the basophile pituitary tumor changes similar to those in parathyroidism have now been frequently encountered. The osseous changes with pathology of the pancreatic islets, the suprarenal bodies have been described, they can be best understood by the simultaneous occurrence of polyglandular adenomas or hyperplasias. The skeletal changes in complete bile fistulas may be only an avitaminosis, at least no endocrine cause is known so far. The lipid changes leading to large defects in the membranous bones may be due to some endocrine changes caused by invasion of the region posterior to the hypophysis by xanthomatous tissue. The etiology of the osseous pathology in the syndrome with leukemic splenomegaly is not understood so far.

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# EMERGENCY COMPLICATIONS OCCURRING AFTER OPERATIONS ON THE STOMACH AND DUODENUM AND THEIR TREATMENT

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COMPLICATIONS which may occur after operations on lesions of the stomach and duodenum and which may give rise to the consideration or necessity for secondary operation on the stomach or duodenum are rare. For this rarity surgeons are indebted to the pioneers in this field of surgery who encountered these complications frequently, and by continually modifying methods of treatment lowered their incidence to a minimum. In accomplishing this, American surgeons played a conspicuous part.

However, in spite of adopting the well-established principles, and carrying them out with meticulous care, complications do occasionally arise which may be directly responsible for death, which may require secondary operation or which may present a most difficult problem as to the necessity of further operation. The possibility of serious complications is always present in this field of surgery, not only because of the nature of the lesions for which the operation has been done and the condition of the patient, but because it is so often found that extensive reconstructive procedures are required to deal adequately with the existing disease. The very fact that with such a combination of factors contributing to the occurrence of complications they rarely do occur makes the problems of secondary emergency surgical conditions, when they are encountered, both intricate and perplexing.

From a surgical standpoint mechanical dysfunction is the major complication which may arise during convalescence following operations on the stomach and duodenum. It is true that the possibility of dysfunction is always present, since all operations for either benign or malignant lesions bring about a change in the mechanics of digestion of greater or lesser degree. It is true also that the nearer any operation approaches success in this respect, the more remote is the danger of motor dysfunction occurring either in the immediate or late convalescence of the patient. In the treatment of ulcer, the operation, whether it is reconstruction of the pyloric outlet, gastroenterostomy or one of the various types of resection must not impair the emptying of the stomach but it must also enable it to be more easily emptied if the best possible results are to be secured in respect to relief of symptoms and to protection against recurrence of ulceration. If operation for ulcer fails to accomplish this improvement in the emptying power, the problem of a secondary operation may be introduced, either for an emergency mechanical defect during the immediate convalescence of the patient or later, for recurrence of ulceration or because of chronic malfunction. Although such

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possibilities may be said to exist always, it can also be said that if the type of operation for ulcer has been well chosen and the details of the operation satisfactorily carried out, no difficulty in gastro-intestinal mechanics occurs

When evidences of dysfunction of the upper part of the gastro-intestinal tract appear following operation for a lesion of the stomach or duodenum, the significance of the symptoms and the indications for treatment will depend, to a considerable extent, on the type of primary operation which has been performed. In reconstruction operations at the outlet of the stomach, whether simple plastic procedures on the anterior wall of the duodenum and pylorus, or partial duodenectomy, or gastric resection in continuity with *end-to-end approximation of the stomach to the duodenum*, any difficulty in the proper emptying of the stomach is not of serious import if the surgeon has felt satisfied at the completion of the operation that an adequate lumen had been created between stomach and duodenum. In such event any retained gastric contents can be aspirated by continuous or intermittent suction, and body fluids can be maintained by intravenous injections of sodium chloride and glucose until the pyloric outlet functions well. Delayed emptying in such cases is probably due to œdema about the reconstructed area, and as this œdema subsides, function is restored. If, on the other hand, the surgeon has been doubtful as to the capacity of the new outlet to function as well as desired, one of two plans can be followed. The first plan is that of performing jejunostomy before accepting the necessity of gastroenterostomy to overcome any impaired motility. Such a plan is preferable in cases in which a primary operation on the pyloric outlet had been chosen because it had seemed more desirable than any other for the future well-being of the patient.

The second plan is that of performing gastroenterostomy or gastric resection as a secondary procedure as soon as it is evident that gastric retention persists. This plan should be followed when the surgeon had felt at the time of the primary operation that the outlet made was not altogether satisfactory, and when there had not been any unusual reason for the type of operation that had been performed. To determine whether the retention is sufficient to justify a secondary operation is occasionally difficult, but if it is shown that most of the fluid taken by mouth is recovered by tube, and no improvement in the situation occurs, it is best to reoperate. If supplementary gastroenterostomy is done, the surgical treatment of the ulcer has then been converted into a procedure which experience has established as one of the most effective methods of dealing with peptic ulcer. It is well, therefore, to keep this important fact in mind when debating the advisability of adding gastroenterostomy to excision and reconstruction of the pyloric outlet, either at the primary operation, or as a secondary procedure. As I have stated, it is only when circumstances dictated against gastroenterostomy as a primary procedure that it should be avoided as a secondary procedure, if the patient is young, gastric acids are high, and motility is unimpaired, gastroenterostomy is not ordinarily indicated as a primary procedure.

Gastro-intestinal obstruction following gastric resection by the Billroth II method or one of its modifications is seen rarely. The gastrojejunal anastomosis in these cases permits much greater leeway in regard to length of the proximal loop than is advisable in performing gastroenterostomy without resection. There are, however, four possibilities by which obstruction following Billroth II resection or one of its modifications may occur. The first results from retraction of the anastomosis into the lesser peritoneal cavity. There is, however, little danger of this, if the mesocolon is carefully sutured to the stomach. Although examples of the accident have been reported in the literature and the complication has been encountered in our clinic, yet retraction of such an anastomosis is not only rare but if it should occur it is probably not as likely to give rise to obstruction as was formerly considered. Support for this belief is in the fact that a continental surgeon of wide experience in this field of surgery does not hesitate to allow the anastomosis to remain in the lesser peritoneal cavity if there is marked difficulty in bringing down the gastrojejunal anastomosis below the level of the mesocolon after a resection.

A second cause of obstruction in this type of operation is adhesion or deformity of the distal loop of the bowel. In one case, I found it necessary to reoperate for severe gastric retention which was caused by a loop of jejunum becoming adherent to the anterior abdominal wall, the gastro-intestinal function was promptly restored following the mobilization of the loop.

A third possible cause of inadequate drainage of the stomach following Billroth II resection is the failure to make an entero-anastomosis between the two loops of jejunum when the gastro-intestinal anastomosis has been made anterior to the colon and consequently on a long proximal loop. There may be sufficient post-operative retention within this loop so that entero-anastomosis may become advisable as a secondary procedure, and recognizing this as a possibility it is good practice to make the entero-anastomosis at the time the primary operation is performed. It is important in this respect to remark that this anterior type of resection is largely confined to extensive operations for carcinoma, so that any question as to the advisability of entero-anastomosis in connection with operation for ulcer rarely arises.

The fourth cause of persistent gastric retention following resections of the Billroth II type is atony. I have encountered only one of this type of case in which a mechanical defect was not discovered, either at second operation or at necropsy, to explain the almost complete inability of the stomach to empty itself after extensive resection for carcinoma, with anterior gastro-jejunosomy and entero-anastomosis. The only clue which offered a possible explanation was that the patient, who was aged more than seventy years, had previously required hospitalization on a number of occasions for severe, protracted and unexplained vomiting.

The method of correction of gastro-intestinal obstruction after the Billroth II operation is obvious under the circumstances of the first three causes.

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Clear evidence that the stomach is unable to pass an adequate amount of material on into the jejunum justifies a second operation. The important feature of such a procedure is that after mechanical difficulties have been corrected, a catheter should be left in the upper part of the jejunum to compensate for the nourishment the patient has already lost. The only procedures possible when the obstruction is due primarily to atony are continuous aspiration of gastric contents and maintenance of fluids and nourishment by jejunal feedings.

From a surgical standpoint, the most serious of all mechanical complications is obstruction of the upper part of the jejunum, proximal to a gastro-jejunal anastomosis used in connection with gastric resection. Real constriction of the lumen of the jejunum at such a site can occur only in cases in which it has been necessary to make some repair of the jejunum, as in jejunal ulcer. The symptoms of such obstruction, resulting as it does in retaining within the duodenum all secretions, are those of increasing shock, severe lumbar pain and toxæmia, death occurs if the obstruction persists. I have observed one case in which this occurred, the obstruction was due to my invaginating into the lumen of the jejunum too much of the wall of the bowel while repairing an extensive defect following gastric resection for jejunal ulcer. The obstruction was a gradual onset, so that the closed duodenal stump, which had been inverted as part of the gastric resection, remained intact. At necropsy the duodenum was about twenty centimeters in diameter, was filled with foul, bloody fluid, and its walls were gangrenous. In any necessary jejunal repair, therefore, it is particularly important when the proximal end of the duodenum is closed, that any doubt as to the adequacy of the lumen of the jejunum be removed by performing enteroenterostomy so as to carry the alimentary content around the site of repair.

The greatest problem in connection with obstruction of the upper part of the gastro-intestinal tract concerns the mechanical difficulties following gastroenterostomy. It should first be emphasized that the performance of gastroenterostomy has been so carefully developed that when it is done on proper indications and according to sound principles of technic, serious mechanical difficulties are extremely rare.

The rarity of a poorly functioning anastomosis, however, does not minimize its importance both from the standpoint of the best treatment of the complication and from the standpoint of providing an explanation for such malfunction. It is true that gastric retention in some degree, during the convalescence of patients on whom posterior or anterior gastroenterostomy has been performed, occurs at least often enough to give added significance to this problem. The occasional occurrence of marked retention between about the tenth and fourteenth days following operation is difficult to explain. Sherren and Walton attributed the obstruction in some cases to a constricting opening in the mesocolon. This retention is not preceded by any evidence of mechanical difficulties, and is not repeated after the stomach is thoroughly lavaged. In some cases indiscretion in the amount of fluid and nourishment



taken unquestionably has been a factor and there is the possibility that at the time of the difficulty the most marked readjustment of gastro-intestinal mechanics is taking place. It is vitally important in this type of case not to permit gastric contents to accumulate again. I have seen the unfortunate results of this in the necessity of a secondary operation because of the disturbance in neuromuscular mechanism, the result of chronic dilatation. On the other hand, careful avoidance of the repetition of such retention after the first week is almost certain to obviate the necessity of any further operation. The obstruction which is most disturbing is manifested soon after operation in the patient's tendency to regurgitate gastric contents and his inability to take fluid nourishment normally. Again, the treatment is of the greatest importance, since, unless there has been gross error in the indications for and the technic of the operation, careful post-operative care in respect to withholding nourishment and keeping the stomach emptied probably will be followed by adequate function. In the rare event of it becoming evident that fluids are not leaving the stomach in sufficient amounts and there is no improvement in this situation, the question of reoperation must be considered.

There are two general principles under which further surgical procedures should be carried out. The first concerns those cases in which it is either known or it is learned at the time of the secondary operation that some defect in the technic of the operation has been responsible for the obstruction. This may have been due either to an error at the time of the operation, such as making too long or too short a proximal loop of jejunum, insecurely fixing an anastomosis below the level of the mesocolon, or making anastomosis at an improper site.

If the cause of persistent retention and regurgitation of bile is a proximal loop of too great length, the difficulty can be promptly corrected by anastomosis between proximal and distal segments of the jejunum. This procedure is of real value only in such cases, it will fail to relieve the obstruction if it is due to any other cause. An entirely different surgical problem is presented in cases in which the obstruction is due to oedema and inflammatory exudate about the anastomosis, in which the anastomosis is too small, in which it is improperly placed, in which the proximal loop is short, or in which there is intussusception of the structures involved in the gastro-enterostomy or intussusception of the distal part of the jejunum into the stomach. I believe that in all such cases the best procedure is to take down the gastroenterostomy by disconnecting the jejunum from the stomach, unless the deformity can be definitely corrected and its recurrence prevented, as in the rare possibility of obstruction from jejunal intussusception, as recently reported by Bettman. Disconnecting the gastroenterostomy may appear to be formidable, especially if undertaken after the second week, for by this time inflammatory exudate has become more firm and mobilization of the anastomosis is not as readily accomplished as in the first ten days after operation. If, however, it is remembered that the anastomosis was made, in all probability, with both the jejunum and the wall of the stomach well out-

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side the abdominal incision, it will be realized that it should be possible again to mobilize the anastomosis so that it is reasonably accessible. The patient's condition usually will not permit an attempt of any other surgical procedure to deal with the condition which it was the purpose of the gastroenterostomy to correct.

Methods other than taking down the gastroenterostomy are occasionally useful and will be successful if the obstruction is caused by inflammatory oedema. If this is the cause a catheter in the distal part of the jejunum, for feeding, and the maintenance of an empty stomach by aspirating with a tube, will carry the patient along until the obstructive oedema has subsided. Walters suggested and described the use of two catheters in the jejunum, one extending up into the stomach from which the gastric secretions could be collected so they could be reintroduced into the feeding catheter. When the obstruction is due to a deformity of the distal loop either from kinking or adhesions, the difficulty can probably be corrected, and recurrence prevented by the introduction of a tube through the anterior wall of the stomach for a distance of about thirty centimetres or more into the distal part of the jejunum. This plan was suggested to me several years ago by W. J. Mayo, it serves a two-fold purpose, that of permitting the administration of nourishment, and establishing a course for fluids to leave the stomach. I have used this plan in two cases. Relief was prompt, and in both cases the tube was removed within a week, with prompt healing of the opening in the stomach.

To select the most satisfactory time to perform the secondary operation is most difficult. Reoperation during the first week following gastroenterostomy is not associated with much technical difficulty and yet it is seldom necessary to reoperate so early, since sufficient time has not elapsed to determine whether it is necessary. Therefore, unless the cause of the obstruction indicates that immediate interference is necessary, operation is usually undertaken during the latter part of the second or in the third week. At this time the technical difficulties of any major procedure are markedly increased since the persisting obstruction and the trauma incident to it have added greatly to the local inflammation. The operation should be further postponed unless it is clearly inadvisable to do so because of the probable subsidence of these inflammatory products and the possibility that the obstruction will be relieved gradually. In other cases postponement may improve the condition although not completely relieve it, and the patient will continue to suffer from intermittent obstruction. Surgical relief during this chronic stage is infinitely easier to accomplish, and it is more effective than during the acute obstructive stage. The opportunities and advantages of studying gastrointestinal mechanics in a chronic condition rather than during an acute upset are, of course, apparent. The place of Röntgen-rays in determining the cause of mechanical difficulties in a gastroenterostomy has not, as yet, been worked out satisfactorily. The correlation of apparent deviations from normal as shown by röntgenograms, and of disturbed function as observed clinically, is difficult, just as is true in other parts of the body. Unnecessary

apprehension and occasionally operation may be the result of too great reliance on the behavior of a gastro-intestinal anastomosis under the fluoroscopic screen

The most accurate indication of the seriousness of any obstruction in the upper part of the gastro-intestinal tract is the resultant disturbance of the chemistry of the blood. Such disturbance, in the early stage at least, can be promptly corrected by adequate intravenous medication, but one should not be deceived by such control into believing that the obstruction is relieved since experience has shown that the obstruction can be complete and yet its toxic effects still be combatted by intravenous medication. If, however, obstruction continues, return to normal of the chemistry of the blood is only temporary, and any unfavorable change in chemistry of the blood, when every means is being used to prevent it, is usually an indication that surgical obstruction exists.

These secondary operations for mechanical complications are usually so urgent that there is seldom justification for considering any substitute for gastroenterostomy if it has been decided to disconnect the anastomosis. Certainly in cases in which there has been little if any obstruction associated with the duodenal ulcer, there would be no urgent need of any operation for the ulcer after the gastroenterostomy has been taken down. If, however, the pylorus has been markedly narrowed by a contracting type of ulcer, the taking down of a gastroenterostomy is a much more serious procedure from the standpoint of the treatment of the disease. In such cases it is desirable after taking down the posterior gastroenterostomy to circumvent the pylorus either by a new gastroenterostomy made anteriorly or by a gastroduodenostomy with or without excision of the contracted area. The double operation can be done, of course, only if the patient is in fairly good condition and if both operations can be done expeditiously.

Adding a second gastroenterostomy when the first one has become obstructed is a makeshift, and it is only a question of time before further operative procedures will have to be carried out. In the cases we have seen in the clinic, in which both posterior and anterior gastroenterostomy had been done previously, the history usually has been much the same, namely, primary posterior gastroenterostomy has been done, uncontrollable gastric retention has developed, and anterior gastroenterostomy has been made. If the patient survives this secondary operation, the relief of the obstruction is usually only partial, and chronic or recurrent vomiting is the sequel. In some cases this is not severe and nutrition is lost slowly. On the other hand, the patient may lose ground rapidly and the surgeon is forced into an operation at a time when local conditions are not suitable for the extensive procedures which are inevitable. In the former group of cases, that is, those which have become more or less chronic and in which the primary gastroenterostomy was done for marked obstruction at the pylorus, I have found the best plan after taking down both gastroenterostomies (which, of course, must be done in any event) is to repair the resulting jejunal defects, then resect the stomach

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to a point above the site of the highest gastroenterostomy, and reestablish gastro-intestinal continuity by anastomosing the end of the stomach, after it has been partly closed, to the second portion of the duodenum. I have found this to be more easily accomplished than might be expected because the state of chronic obstruction has stretched the stomach and the first and second portions of the duodenum.

This consideration of the obstructive complications which may require secondary emergency operations following operations for lesions of the stomach and duodenum may give a false impression as to the incidence of such complications, for in the aggregate, when the primary operation is clearly indicated and the principles of surgery of this field are really followed, the complications are exceedingly rare.

Small as the incidence of the complications named, it is nevertheless true that when they do occur they are most serious and whether or not they require secondary operation they always confront the conscientious surgeon with the question of whether that particular complication might have been avoided. It cannot be expected that such complications can be completely prevented, but meticulous care in the selection of the type of operation, and in its performance by the surgeon with adequate experience, will hold such complications to a minimum.

# CLOSURE OF THE ABDOMEN WITH THROUGH-AND-THROUGH SILVER WIRE SUTURES IN CASES OF ACUTE ABDOMINAL EMERGENCIES

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ALTHOUGH silver wire has long been used as a suture material in surgery, there are few published reports regarding the various methods of its application. The impression is gained that its use in the past has been more or less sporadic, and that at the present time it has been practically abandoned. For more than ten years we have been using it extensively at the Cincinnati General Hospital in the closure of abdominal wounds in certain selected types of cases, and have found a constantly widening field of usefulness for it.

In the method to which we refer, silver wire is used in a series of interrupted sutures through the entire thickness of the abdominal wall—skin, fat, fascia, muscle and peritoneum—no other sutures being used except, occasionally, a few in the skin to keep the edges of the wound from everting. It is not quite clear to whom the credit belongs for first using this method, although in Professor W S Halsted's Clinic in Baltimore a similar method was frequently used for closing wounds which had broken open following operation. It is known that Dr C L Bonfield, of Cincinnati, used silver wire for closure of the abdomen in certain cases. Only published report we have been able to find is one by Shipley,<sup>3</sup> in 1925, which deals only with the secondary closure of ruptured abdominal incisions. Hoyer<sup>1</sup> also reported use of an aluminum-bronze wire in a somewhat similar manner in 1927, and Minn and Akush<sup>2</sup> report the use of fine silver wire in continuous suture in layers.

The method as we use it is as follows. Ten- to twelve-inch lengths of virgin silver wire,\* No. 20 gauge, are threaded on large, curved, cutting edge needles such as are ordinarily used for inserting "traction" or "tension" sutures. The short end is folded back over the eye of the needle and crushed flat with a heavy forceps so the wire will more easily go through the hole made by the needle. A clamp is fastened on the free end as is done with silkworm-gut "stay" or "tension" sutures. A series of clamps is placed on the edge of the peritoneum. All the silver-wire sutures are then placed but not tied. For each suture the needle is started about one or one and a half inches from the edge of the incision and carried through the entire thickness of the abdominal wall, including the peritoneum. The suture is continued by bringing it out at a corresponding place on the opposite side of the incision. It is important that no kinks be allowed to get in the wire during this step as they are exceedingly difficult to get out smoothly. The needle is unthreaded and a clamp placed on the free end of the wire. A series of such sutures is placed about one and one-quarter to one and one-half inches apart, five to eight being used to close the average incision. After all are placed, the clamps on the

\* The most pliable wire should be used. It is our custom to buy it in one-ounce lots and rolled on a spool.

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peritoneum are removed and the incision closed by pulling up and twisting each wire individually. Beginning at one end of the incision, the operator pulls up on the clamps at opposite ends of one suture. The first assistant puts a finger inside the abdomen and reports when the wire is pulled sufficiently tight to bring the peritoneal edges in firm contact. The wire is then twisted six to eight times just above one of the openings through which it emerges from the skin—not over the line of incision. Each wire is pulled up in succession and twisted. (Figs 1, 2, 3 and 4) It is extremely important that the desired tension be obtained before the twisting is started because the twisting is for the purpose of holding only and will not tighten the suture nor remove any slack in it.



FIG 1—Method employed in pulling up and twisting the wire sutures. The finger in the abdomen protects the intestines, and lets one know when the suture is pulled sufficiently tight.

After all the sutures are fixed in this way, one or two silk stitches may, if necessary, be placed in the skin between each two wires to prevent eversion or inversion of the skin edges. The wires are cut rather long, as they are easier to manipulate in the dressings if an inch or more of straight wire is free beyond the twisted part. No rubber tubing or other material is placed about the wires where they cross the incision or between the wires and the skin. There is usually some cutting of the skin under the wires before they are removed, but this has never constituted a serious complication of wound healing. Various modifications have been tried in an effort to prevent this cutting of the skin, but the method just described has been more satisfactory than any of the modifications.

This entire procedure can be carried out in only a fraction of the time necessary for a formal closure of the incision in layers

It is also possible by this method to close a wound which is under considerable tension or one in which the peritoneum fails to hold sutures but tears with each attempt to pull it together. In addition, this closure is extremely valuable in all cases in which there is likely to be infection, as it gives a very secure closure which is not affected by infection or even by extensive slough of the fascia. Indeed, it was this property which first led to the adoption of this method in closing the abdomen after such acute traumatic conditions as gunshot wounds and stab wounds.

Prior to the use of this method, there occurred four instances of post-operative rupture of the abdominal wound in cases of gunshot wound of the abdomen in the one year 1922 alone. Since its adoption there has been no

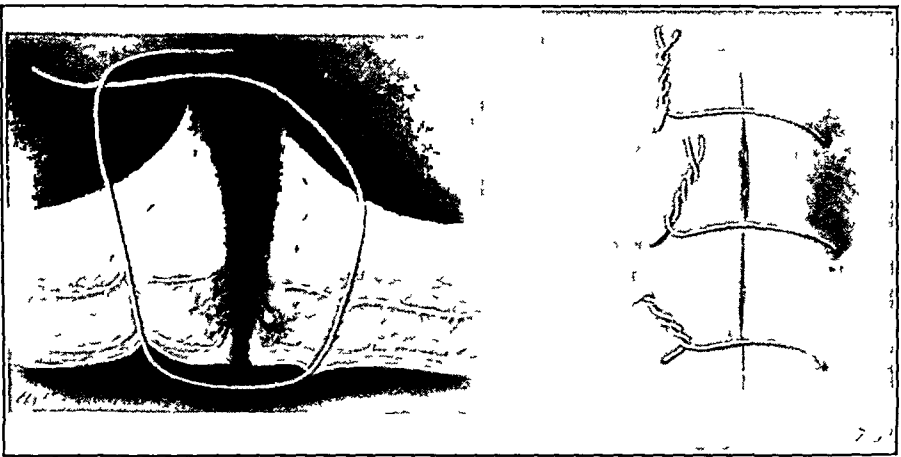


FIG 2—Diagram showing position of the wire and illustration of the wound after closure

case of rupture of an incision closed by silver wire during ten years. There have been two instances only in which a loop of bowel or bit of omentum protruded between two wire sutures due to the fact that they were placed too far apart or were not sufficiently tight.

We have been able to find and review the records of 334 patients in which this type of closure was used. Since these cases were operated upon for widely varied conditions, and were not filed together, nor was any cross index available as to the type of abdominal closure, we have undoubtedly overlooked many other instances in which silver-wire closure was done. In a few of the earlier cases a continuous suture of catgut was first placed in the peritoneum, but this has been found to be unnecessary and is no longer used.

With this type of closure, the following objections and disadvantages may be raised. The most marked objection is on the part of the patients, who, almost without exception, complain of pain in the incision. In spite of using the most pliable silver wire we can get it is more stiff than other suture material, and causes more pain than the average "tension" or "stay" sutures. Second, there is usually some infection around the wire. This may be

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minimal and the incision itself heal without infection, but it is rare to have no discharge from the wire holes, although this is no greater than that which occurs around other sorts of "tension" or "stay" sutures in the same kind of cases. Third, there is usually some cutting of the wires into the skin, which causes an obvious cross-hatching of the incision, and in patients with a tendency to keloid formation this may lead to a disfiguring scar. Fourth, the theoretical objections of incomplete closure of the peritoneum predisposing to hernia and obstructive intra-abdominal adhesions have not been borne out in fact. Fifth, we have never seen a block slough of the tissue enclosed by the sutures, although the possibility of occurrence has been a source of worry.

It is our opinion that the method offers the following advantages. First, the closure is very secure. In spite of severe infection, we have had no case

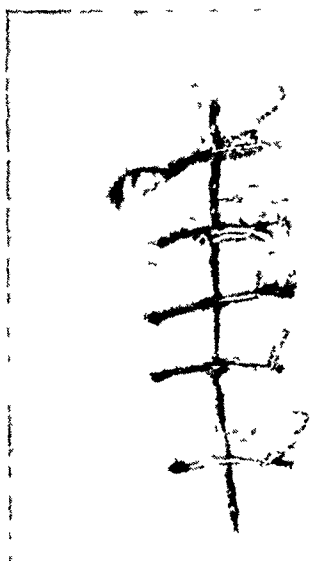


FIG 3—Photograph of wound five days after closure with silver wire

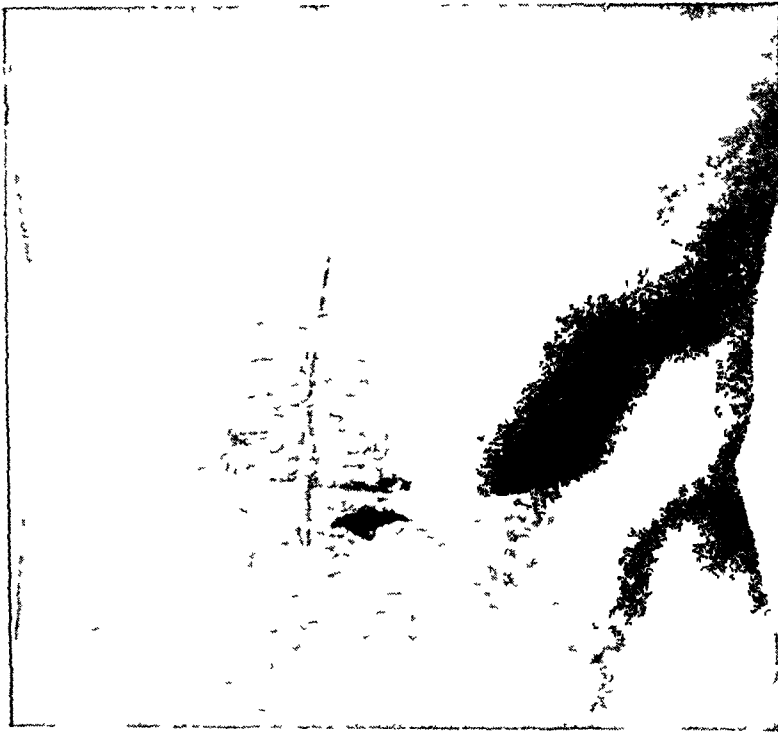


FIG 4—Photograph of wound several months after through and through silver wire sutures

of post-operative rupture of the incision and no evisceration. In two cases of the 334 reviewed a loop of bowel or bit of omentum slipped out between the wires which were too far apart or not sufficiently tight. One additional case of this sort occurred in 1933 which is not included. Second, the closure can be carried out very rapidly, so that patients in critical condition can be got off the operating table very quickly after completion of the intra-abdominal manipulations. Third, it can be used to close an abdomen under tension, for example, in the case of an intestinal obstruction, and when other sutures fail to hold. Fourth, an incision of this sort can be easily reopened by untwisting the wires, if a second operation is necessary shortly after the original one. The wires can be pulled aside, the necessary procedure carried out, and the wires pulled up and retwisted. Fifth, in cases of peritonitis or potential infection, such as is present after the perforation of a hollow viscus, the



closure with interrupted sutures allows the escape of peritoneal exudate between the sutures without the placing of drains. The absence of any suture material directly in the line of closure of a contaminated incision predisposes to more benign wound healing and reduces the liability to infection. Sixth, the closure is so secure that old and debilitated patients can be got out of bed very early, as soon as five to seven days after an operation through a long rectus incision. Seven, the incidence of post-operative ventral hernia is no greater than after other more formal types of closure in the same types of cases, so far as we have been able to determine. Although late follow-up records are not available in many of the patients, we know of only three in which hernia has occurred.

A short tabular review will show clearly the types of case in which we use this closure and our increasing use of it.

TABLE I

*Number of Cases by Years*

1922	1	1928	45
1923	8	1929	31
1924	16	1930	38
1925	23	1931	51
1926	38	1932	54
1927	29		
<hr/>			
Total eleven years			334

TABLE II

*Number of Cases According to Lesion Present*

Gunshot wound of abdomen	126
Intestinal obstruction	57
Ruptured peptic ulcer	45
Gall-bladder operations	21
Stab wound of abdomen	20
Carcinoma stomach and colon	15
Post-operative evisceration	8
Traumatic rupture hollow viscera	8
Miscellaneous (peritonitis, ileus, pancreatitis, gangrene of bowel, etc.)	34
<hr/>	
Total	334

It is interesting to note that there have been only eight cases of post-operative evisceration in eleven years and none of these occurred when silver wire was used. We attribute this low incidence to the fact that we use silver wire to close practically all wounds in which evisceration is prone to occur. In this connection we wish to call attention again to the fact that in the year 1922 alone, four cases of post-operative rupture of wounds occurred following operation for penetrating gunshot injuries of abdomen in which closure was done with continuous catgut suture of the peritoneum, interrupted catgut suture of the fascia, reinforced with silkworm-gut "stay" sutures.

When silver wire is used in this manner, the sutures are ordinarily removed about sixteen to eighteen days after operation. If they are found

## WIRE CLOSURE OF ABDOMEN

to be too tight at any time, they can be loosened by untwisting them, allowing a little slack to be taken up by the wound and retwisting them. A statistical study of our cases in which the data were complete showed that the shortest time at which any sutures were removed was six days, the shortest time before all were removed was ten days, and the longest any were allowed to remain was thirty-seven days. Ordinarily, part of them are removed about the fifteenth or sixteenth day, and the remaining ones the seventeenth or eighteenth day, though at times all of them are removed at one stage. The accompanying table shows the times at which the first and last wires were removed.

TABLE III

	<i>First Sutures Removed</i>	<i>Last Sutures Removed</i>
Earliest	6 days	10 days
Latest	25 days	37 days
Average	16 13 days (142 cases)	17 81 days (119 cases)

Infection of the wound is of frequent occurrence, as was pointed out earlier. This is to be expected from the nature of the cases in which the method is used. In the study of our 334 cases, sufficient data regarding infection were available in only 194. Infection is listed in the accompanying table as severe, moderate, mild, and none. By these designations the following conditions are to be understood. "Severe" is applied to those in which there was marked infection with induration, profuse purulent exudate, and gangrene and slough of the deep structures. "Moderate" indicates those in which there was redness, induration, purulent exudate, but little or no slough. "Mild" refers to those in which there was slight redness and induration of the suture line with a little exudate from the suture holes only or from only a portion of the incision. "None" indicates no purulent exudate, though induration and redness may have been present.

TABLE IV

*Incidence of Infection in 194 Cases*

	No of Cases	Percentages
Severe	33	17 %
Moderate	48	24 7 %
Mild	69	36 %
None	44	22 6 %

In the follow-up examinations to determine the presence of hernia as a late complication, only thirty-one patients were seen sufficiently long after operation to justify an estimate as to the solidity of the wound. In three of those that were examined more than six months after operation a hernia was present. In these three cases one had a fecal fistula develop through the wound following operation for intestinal obstruction, one had severe infection, the third had no infection, but developed cirrhosis of the liver with ascites. The inference is that the incidence of hernia is low, but both the

proportionate and the total numbers of our cases are too few to permit conclusions to be drawn

In addition to these cases in which silver wire alone was used in closing the abdominal wall, it has been found that there are 199 additional cases in which silver wires were used as "stay" sutures, the remainder of the closure being done in layers. This use of wire sutures has developed during the past three or four years, but is being used with increasing frequency in borderline cases in which infection of the incision is liable but not certain to occur, and when in addition, the condition of the patient does not require a rapid closure. It is more secure than when silkworm gut is used.

In conclusion, we wish to present briefly some of the important features of a few cases in which the silver-wire suture had some interesting bearing

UNUSUAL CASES—CASE I—(J 75) J McD *Gunshot wound of the abdomen with multiple perforations of the intestine*. At operation only three silver wires were available. Wound closed with three silver-wire sutures, alternating with three sutures of triple strands of silkworm gut. On the second day the patient became irrational and got out of bed, and the silkworm-gut sutures broke. He was returned to the operating room and three additional silver-wire sutures were put in. The wound became moderately infected. Sutures removed twelfth and sixteenth days, and patient discharged thirty-second day.

CASE II—(J 7080) P G *Gunshot wound of the abdomen with perforations of the intestine and cæcum*. On the fourth day a loop of bowel came out between two sutures. Two sutures removed and five new ones inserted. Patient died on tenth day—peritonitis.

CASE III—(N 7287) J J *Gunshot wound of the abdomen with perforations of the intestine*. On seventh day an intra-abdominal abscess drained spontaneously through the incision, but while there was severe infection there was no evisceration. First suture removed twenty-fifth day. Patient discharged fifty-third day.

CASE IV—(Q 7079) A W *Gunshot wound of the abdomen with perforations of the intestine*. Operation. Closure of perforations and jejunostomy. At close of the operation in removing the drapings the jejunostomy tube was pulled out. Patient redraped. Silver wires untwisted, tube reinserted and wound closed again. Moderate wound infection. Stitches removed twenty-first and twenty-second days. Patient up twenty-fourth day. Discharged fortieth day.

CASE V—(P 674) J W *Gastric ulcer, excised, gastroenterostomy*. Omentum came out between wires sixth day. Two new wires placed. Moderate wound infection. Sutures all removed twenty-first day. Patient up twenty-fifth day. Discharged twenty-eighth day.

CASE VI—(L 5369) G M *Crush of liver*. Packed with gauze roll. Pack removed second day by untwisting wires and then tightening them up again. The patient developed subphrenic and intra-abdominal abscess. Severe wound infection. In hospital 104 days. No hernia at time of discharge.

CASE VII—(Q 11668) H P *Intestinal obstruction*. Jejunostomy done. Patient up in chair seventh day. Walked twelfth day. Sutures out eighteenth day. Wound healed per primam.

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## SOME LIMITATIONS OF ENTEROSTOMY

BY ALEXIUS MCGLANNAN, M D

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ALMOST from the beginning of surgery some means of opening the distended loop has been the accepted method for treatment of acute intestinal obstruction (McIver *Amer Jour Surg*, new series, vol xix, p 167, January, 1933 )

Unless it is the result of complications, death is due to toxæmia Experimentally, a high obstruction can be produced without interference with the vascular supply, but Jenkins and Beswick (*Arch Surg*, vol xxvi, p 427, March, 1933) note that in some of their cases death may have been due to obstruction Clinically, interference with the vascular supply of the distended loop makes changes occur in the mucous membrane in all obstructions of the small intestine

Whenever there is interference with the nutrition of the epithelium there is toxæmia (Van Buren *ANNALS OF SURGERY*, vol lxxii, p 610, November, 1920 ) It is possible to have a simple high obstruction without toxæmia but this is very rare and can only occur early in the course of the disease Here intravenous injection of a solution of sodium chloride (Orr *ANNALS OF SURGERY*, vol xciv, p 732, October, 1931) or better the salts of sodium, potassium and calcium properly buffered (Elman and Hartman *Graham's Year Book Publishers*, p 415, Chicago, 1932) is necessary for the prolongation of life With toxæmia some method of getting rid of the toxic material must be added to the introduction of the electrolytes In such a case it is obvious that enterostomy alone will not cure the patient

High obstruction is a rare condition, it occurred only eight times in the 335 cases reported by McIver from the Massachusetts General Hospital (*Arch Surg*, vol xxv, p 1104, December, 1931 ) Unless the cause of the obstruction is removed a simple enterostomy above the obstruction will allow the contents of the high intestine to flow out without relieving the obstruction, a condition which is borne but a short time by the host in spite of the administration of sodium chloride and water hypodermically This limits the value of enterostomy in high obstruction

With the slightest degree of strangulation the absorption of toxins ensues and the treatment with salt solution does not prevent death from toxæmia (Gatch *Amer Jour Med Sci*, vol clxxiii, p 660, June, 1927 )

Lower down in the intestinal tract the fall in the salts of the blood is not as prominent as is the toxæmia Here enterostomy added to whatever is the proper treatment of the obstruction may be the life-saving feature If the enterostomy is delayed, air pockets and particularly paralysis of the bowel will prevent its action and the patient will die from his obstruction

Multiple enterostomy opening the bowel in two or more places, or a high enterostomy above the paralytic portion may be a dangerous expedient. The greater the damage to the bowel the more marked the toxæmia and the height of the obstruction plays some part in the outcome of the disease.

In the great majority of acute intestinal obstructions some degree of dehydration is present. Proper administration of adequate volumes of salt solution before and after operation will be a factor in the outcome of certain cases.

If enterostomy is performed above the point of obstruction, tension will be relieved and the bowel regain its tone. Recent fibrinous adhesions will often be absorbed.

When the patient is very sick enterostomy is done under local anæsthesia without a thorough exploration, but there is some danger of overlooking a strangulation.

In the large intestine the obstruction almost always originates from within the bowel and only in the late stage involves the vessels. Whether it is due to involvement of the lumen alone or not, enterostomy across the abdomen from the seat of the obstruction is a useful preliminary. We have had experience with enterostomy where the flow of material was fast and where it was slow. Probably the best results had followed a slow flow of the material because this has made slight impression on the blood pressure. But we have had some brilliant results follow a rapid flow of the material.

The toxin of intestinal obstruction is probably due to bacterial action on the contents of the obstructed loop (Gatch Surg, Gynec, and Obst, vol xvi, p 332, March, 1928), although the experiments of several observers point to an altered action of the glands of the intestinal wall and pancreas as the cause of the toxin. Thus Whipple, Stone and Bernheim and later Whipple and other associates (Jour Experi Med, vol xix, p 166, 1914), (Jour Amer Med Assn, vol lxxvii, p 15, 1916), isolated a proteose from the toxic contents of an obstructed loop of duodenum. Whatever the nature of the toxin it is deadly to animals of the same species and a man who has received his lethal dose will die in spite of any attempt at treatment. For this toxin we have no anti-toxin or antidote.

Enterostomy is useless in the presence of such a dose. Unless a patient is moribund we have no means of estimating the dose of toxin which he has received or the extent of paralysis of the bowel before the abdomen is opened. Enterostomy under such circumstances is a forlorn hope.

In about 300 cases 77 per cent of the non-gangrenous patients were cured by enterostomy. However subtle may be the exact cause of death in intestinal obstruction there can be no doubt that the accumulated material in the occluded bowel is extremely toxic and has a considerable influence on the production of toxæmia. Therefore it is necessary that in the presence of toxæmia we provide an outlet for this accumulated material by making an opening into the bowel above the obstruction. Whether we shall do more depends on the general condition of patient and his lesion.

## RUPTURE OF THE LIVER WITHOUT TEAR OF THE CAPSULE

BY D E ROBERTSON, M D , AND ROSCOE R GRAHAM, M D  
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CASE I—On the 20th of October, 1932, a boy, aged fifteen years, received a blow to his epigastrium while playing football. He was knocked on to his back. He was able to get up with difficulty, and after resting, he cycled home. On his way home he had a "spell" and had to rest for a while. On arrival home he felt better and when his physician was called to see him that night, the physician could find no abnormality excepting a complaint of tenderness in the epigastrium. No rigidity was noted. The boy slept fairly well that night, but was somewhat disturbed by pain in his right shoulder, so that he was under the impression that he had injured the shoulder in his fall. He was confined to bed the next morning by order, but he was allowed up for lunch. During his lunch he was attacked by a very severe pain in his epigastrium, which was followed by vomiting. The vomitus was clear of blood. He was seen by his physician late in the afternoon, after having three or four hours of agonizing pain. His physician found the boy in shock, with a pulse of 130, complaining of inability to lie on the left side on account of pain being made worse. He had pain just under the right shoulder-blade and in the epigastrium. A large round swelling was to be seen just below the right costal margin.

I saw him early in the evening, when his condition was not materially changed. His shock was pronounced. Examination of his abdomen revealed the large round swelling in the epigastrium, but to the right of the mid-line, seeming to arise from under the costal margin, and seeming to be attached to the liver. The margin of the liver could not be felt. There was no general peritoneal tenderness, and there seemed to be no peritoneal irritation. There was no rigidity of the abdominal muscles. The veins of the skin of the lower abdomen were engorged and stood out prominently.

It was felt that a transfusion might be of benefit in improving his condition. He was therefore transfused with 450 cubic centimetres of blood, but this in no wise influenced the condition, insofar as one could judge.

The agony of the patient made it imperative that there be some active surgical interference. On reviewing the history of the events, and having consideration for the physical findings, *viz* the absence of peritoneal irritation, the presence of the tumor, its intimate relation to the liver, the great distress and the high degree of shock, together with the enlargement of the superficial veins, made it appear that he had a hæmorrhage in which increasing pressure was the factor producing the great disturbance. The physician suggested this was a rupture of the liver without tear of the capsule. It was decided to operate upon him.

Under general anæsthesia the abdomen was opened and the liver was immediately seen to have a large swelling on its anterior aspect extending up over the dome. This tumor was dark red and looked like an enormous blood blister. It did not extend quite down to the inferior margin of the liver. The general peritoneal cavity had no excess of fluid present and there was no free blood. The gall-bladder was markedly œdematous. An aspirating needle was introduced into the hæmatoma under the capsule of the liver and ten or fifteen cubic centimetres of blood aspirated, when the needle became blocked. On withdrawing the needle the blood spurted through this small opening in the capsule to the height of six or eight inches, which demonstrated the enormous pressure present in the hæmatoma. The capsule was opened widely to allow the complete evacuation of the cavity, and the exploring finger was able to identify a rent in the liver substance, but on

account of the clots that were present it was impossible to determine the extent of the tear in the liver. A drainage tube was introduced into the cavity and the capsule closed, which was readily accomplished, with catgut. A stab wound was made in the abdominal wall opposite the cavity and the drainage tube pulled through this. The abdominal wound was then sewn up.

The first eighteen hours following operation proved to be fairly stormy—high temperature, fast, thready pulse. It was necessary to transfuse the patient again twelve hours after operation. This improved his condition considerably. His pulse rate was in the neighborhood of 140 for the next day or so, with some irregularity of the heart. There was considerable drainage from the tube for the first forty-eight hours, but at no time, either during the operation or subsequently, was there any sign of bile. After forty-eight hours the tube was removed, and there was further discharge for another forty-eight hours when it finally closed. The patient went on to make an uninterrupted and complete recovery, and at the present time, May, 1933, he appears entirely well and has no limitation of activity.

CASE II—(DR ROSCOE R GRAHAM) A boy, aged fourteen years, was injured in an automobile accident on December 10, 1932. The manner of the accident is of some importance. While sitting in the back seat of a car, a collision occurred, in which he was thrown violently forward, striking his lower right chest on the back of the front seat.

Examination at this time by Dr Kenneth Sinclair, of North Bay, Ont., showed a fracture of the fourth, fifth, sixth and seventh ribs on the right side near the spine. He was admitted to hospital, where he remained for about ten days. On admission his pulse rate was 140, and took about three days to reach 90. It was accompanied by a slight fever. Stereoscopic roentgen rays of the chest taken at this time showed some slight elevation of the dome of the diaphragm on the right side, but no evidence of fluid in the pleural cavity, and the fracture of the ribs could be demonstrated.

He returned home until January 1, 1933, at which time he reported to his physician, who discovered a large tumor in the right upper abdomen. At this time his pulse was 96 and his temperature 97.4°. He did not seem to be suffering any undue pain, and had no great dyspnoea, but during his stay at home he did complain, not only of some discomfort in the right upper quadrant, but also of pain at the tip of the right shoulder. At this time stereoscopic roentgen rays of his chest were taken, and showed the diaphragm had reached the level of the third rib anteriorly, still no evidence of fluid in the pleural cavity. Movement of the diaphragm on fluoroscope was greatly restricted.

A barium meal was given, and this showed the greater curvature of the stomach displaced to the left, and also a very marked displacement to the left of the descending duodenum.

He was then placed under our care in the Toronto General Hospital, and consultation with Professor Duncan Graham gives the following notes:

"On examination there was no expansion of the right chest below the fourth rib. The trachea was in the mid-line. On percussion, resonance was impaired from the second interspace downwards in the mid-clavicular line. The impairment was more marked from the fourth interspace downwards. The findings at the same level in the mid-axillary line were the same. Skodaic resonance was absent above the area of more marked impairment of resonance. Breath sounds absent over area of definite dullness, normal over remainder of chest. Marked fulness in right upper abdomen extending across the mid-line to near the mid-clavicular line on the left side. This latter area was dull to percussion, but not tender. Traube's space was obliterated, and cardiac impulse was in the fourth interspace on the left side. No definite edge to the liver could be felt. Temperature, 99°, white blood-cells, 8,000. The findings suggest a collection of fluid between the liver and diaphragm, more marked on the right side, but extending across the middle line and obliterating Traube's space. As toxic symptoms are absent, and some degree of fulness has been present for over three weeks, subphrenic abscess is un-

## RUPTURE OF THE LIVER

likely In view of the history of the injury, the condition suggests a subcapsular hæmorrhage of the liver "

With the above findings, it was considered advisable to explore his abdomen, which was done under spinal anæsthesia on January 6, 1933 The following are the details of the operative note

"The abdomen was opened by displacing the upper right rectus laterally, and one found the huge mass to be a collection of fluid confined within the capsule of the liver, extending quite up to the third rib One could pass the hand over the dome of the liver There were some fine, filmy adhesions, but there was no rent in the capsule The base of the liver was shoved downwards by this huge collection of fluid, and explained the displacement of the duodenum and greater curvature of the stomach to the left, and it displaced the falsiform ligament well to the left side, also explaining the physical signs of obliteration of Traube's space The capsule of the liver was then incised, and over two quarts of old blood and bile were evacuated There was no evidence of infection The surface of the liver as palpated through the opening in the capsule seemed to be rough and irregular, and bled fairly freely, but there was no alarming blood loss There seemed to be some diminution in the volume of the right lobe of the liver One could not determine anything grossly disturbed in the left lobe A stab wound was made to the right of the laparotomy wound, and the edge of the capsule sutured to the peritoneum and fascia, thus marsupializing it The cavity was then loosely packed with gauze saturated with an aqueous solution of 1 in 1000 acriflavine"

*Progress*—Twenty-four hours post-operative the fulness had almost entirely disappeared in the upper abdomen and Traube's space was more resonant The upper level of the diaphragm on the right side was still at the third interspace The degree of shock following operation was not great, his pulse never exceeding 130 and the temperature never going above 102° This gradually came down over a period of two weeks, until the temperature rarely exceeded 99° and the pulse rate rarely exceeded 100 There was still a fairly free discharge from the wound

January 25, 1933—The patient was comfortable, walking about, dulness in Traube's space more marked Liver palpable on the right side two fingers below the costal margin, upper level of the diaphragm third rib, some lateral movement of the right lower chest, but no movement antero-posteriorly It was evident that the liver was not in contact with the diaphragm Discharge from the wound has been very much less, and despite attempts at exploration of the cavity, no great volume could be evacuated Discharged from hospital January 30 Still some drainage General condition excellent

February 6, 1933—Patient observed under the fluoroscope The dome of the right diaphragm at the third rib shows very little movement Left diaphragm moves well There is a definite collection of air between the diaphragm and the liver Dulness in Traube's space has decreased Patient complains of aching pain in the right shoulder on attempting to straighten up General condition excellent

February 16—Patient spontaneously evacuated over a quart of bile and blood-stained fluid through the sinus

March 23—Still fairly free discharge from the sinus General condition excellent Gaining weight and suffering no disability Rontgenogram of chest shows that the dome of the diaphragm was at the level of the fifth rib mid-axillary line

May, 1933—Discharge ceased in April Now well in every respect

In reviewing the literature, we have been able to find three communications dealing with this lesion

Wulsen<sup>1</sup> reports the case of a girl who suffered an abdominal injury by colliding with a fence while riding upon a sled Following an acute shock, accompanied by vomiting, this girl improved, but was not able to leave her bed, and four weeks after the accident was admitted to hospital There had been no fever, but she had vomited bright red blood



and had persistent epistaxis. The abdomen was slightly distended. There was diffuse tenderness in the region of the liver and the spleen, the liver being about four centimetres below the costal margin. Her hæmoglobin had dropped to 27 per cent and her red cells to 1,120,000 with 9,200 white blood-cells. She was carried on intravenous glucose therapy, and at times developed a fever which would reach 103°. The stools were free and of coal-black color. The hæmoglobin decreased to 19 per cent. Röntgenogram showed the right diaphragm a hands-breadth higher than the left, no purulent exudate. Death occurred on April 13. Autopsy findings revealed a cavity about the size of a child's head in the upper portion of the right lobe of the liver. The capsule of the liver was intact everywhere. The cavity contained large quantities of old blood clot in a dirty brownish-red fluid. At several sites the coagula had a greenish color. The upper margin of the right lobe of the liver was at the level of the third rib. Numerous subpleural and subpericardial ecchymoses, similar ecchymoses in the mucosa of the small bowel and in the pelvis of both kidneys. The remote vascular lesions were presumed to be the result of decomposition products developing in the cavity producing toxic vascular lesions.

Brandberg<sup>2</sup> reports a boy fourteen years of age who suffered an abdominal injury while riding a bicycle and colliding with a bus. This patient, in addition to fractures of the arm and an avulsion of the right sacro-iliac joint, had hæmaturia. This gradually cleared up as did a slight abdominal sensitiveness. The patient, however, continued to complain of paroxysms of pain radiating from the epigastrium to the left shoulder. The attacks lasted from five to ten minutes and occurred several times daily. Thirty days following the injury, tenderness in the abdomen had increased, and there was a definite sense of mass. Laparotomy was performed. A large subcapsular collection of about three litres of bile was evacuated, and the capsule marsupialized. This patient went on to recovery. Brandberg also reports six other cases of similar injury following the same trend of clinical course.

Anderson<sup>3</sup> reports the case of a laborer thirty-six years of age who was run over by an automobile. Four days after admission he suddenly collapsed from what was evidently an abdominal hæmorrhage. At laparotomy they found delayed rupture of the spleen, with about two litres of free blood in the abdomen. Two weeks following this operation the patient became jaundiced, developed a right-sided pleurisy, and the right diaphragm was high and immobile. Nine days later exploration was done for a subphrenic abscess, and it was found instead that there was an abscess in the liver, with an intact capsule. This case probably represents an incidence of a subcapsular rupture which subsequently became infected. The fact that the organism cultured was a diplococcus leads one to believe that the source was through the blood-stream, rather than from the bile passages.

*Comment*—There are several interesting factors which are worthy of consideration in the two cases presented, which show a striking similarity to the cases which have previously been reported. In all the recorded cases, and in Case II of this group the length of time which elapsed between the injury and the recognition of the fact that the patient was suffering a serious injury is remarkable. In all except Case I here reported, the tumor has not been present at the time of the original examination following the injury but has slowly developed and has been recognized some days or weeks later. We are led to conclude that the rapid appearance of the tumor, and the early recognition of a serious accident in Case I, is explained by the fact that the content of the subcapsular tear was largely blood. This was substantiated at operation, where practically no bile was found in the cavity, whereas in Case II and in the cases reported in the literature, the tumor was largely produced by the slow accumulation of bile mixed with blood in the

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subcapsular rent Both the reported cases were complaining bitterly of pain referred to the right shoulder, which is interpreted as being due to irritation of the diaphragm, and this finding in a patient who is suffering an abdominal injury is probably of real significance and worthy of careful consideration before being dismissed

The height to which the diaphragm was able to rise in Case II was remarkable, when one considers that it was due to a subcapsular effusion, and that the capsule remained intact We have seen displacement of the diaphragm to this degree previously, only in cases of very severe ascites

The absence of fluid in the chest, and the absence of physical findings on examination of the chest, apart from sternal resonance, we believe to be of real value, and the finding of this resonance is helpful in excluding an associated hæmothorax

In Case II and in the reported cases the initial high fever is difficult to explain except as a result of broken-down blood-cells and decomposition product resulting from damaged liver tissue That this effusion can remain uninfected for such a long time is most interesting, and in the reported cases we were able to find only Anderson's<sup>3</sup> case in which there was a late infection of the contents of the cavity, which he concluded was of a hæmatogenous origin

*Conclusions*—(1) Two cases of subcapsular rupture of the liver with operation and recovery are reported

(2) In Case I the seriousness of the injury was recognized early, the tumor appeared early, and at operation the cavity was found to be filled only with blood

(3) In Case II there was a long latent period of well being between the accident and the appearance of the tumor, which at operation contained bile and blood, and was accompanied by gross destruction of liver tissue

(4) If a patient suffers an abdominal injury with distress referred to the right side and accompanied by pain in the shoulder, early exploration is advisable, as there will be a shorter convalescence and it will avoid destruction of liver tissue should the diagnosis prove to be a subcapsular rupture of the liver

(5) If the tumor occurs soon after the injury, we presume its contents will be blood, and drainage with a tube appears to be the ideal method of handling it If, on the other hand, it is late in forming, bile will constitute an important volume of the content of the cavity, and marsupialization is desirable

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# FOREIGN BODIES IN THE BILIARY TRACT

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FOREIGN bodies in the biliary tract are rarely encountered and seldom suspected until seen at operation or at the necropsy table. Their occurrence is so infrequent they are not mentioned in many text-books on diseases of the biliary system. Perhaps as pathological curiosities they merit little attention in standard text-books. To the individual surgeon who has been confronted by one of these unusual cases they present many interesting and puzzling features. We wish to review the literature and to report an additional case.

**CASE.**—A male aged forty-nine was admitted to the hospital December 2, 1932 with a chief complaint of jaundice. The family and past history were irrelevant. He never had had typhoid fever. His health had been excellent until about one year prior to admission when he began to have occasional pain in the upper right abdomen. There was no jaundice or any other untoward symptoms. The attacks were not severe. An X-ray dye study revealed a pathological gall-bladder and an operation was advised.

On June 2, 1932 a cholecystectomy was performed by another surgeon. There were no gall-stones present. The head of the pancreas was enlarged and the liver showed pathological changes. The common duct was not opened. A Penrose drain was used for drainage. Three days after operation a sudden severe jaundice developed. There was no pain, chills or fever but on the fifth day he developed considerable upper abdominal pain. The jaundice persisted about three weeks, clearing gradually. For about four months he felt fairly well but he did not regain his strength and continued to have mild indigestion. There was no jaundice or itching and the stools were brown. Then he began to notice a slight jaundice. There was no pain. The urine was dark and the stools light in color. The jaundice became gradually worse up to the time of his admission. It would improve at intervals and the stool would show some bile. The itching of his skin was very troublesome. He felt weak and had occasional nausea. He lost about twenty pounds in two months. During this period blood examinations showed an anæmia and the possibility of a primary anæmia was considered.

There were no symptoms referable to the cardiovascular, pulmonary or nervous systems.

The blood-pressure was 134 systolic and 88 diastolic. The pulse averaged 76. There was a diffuse moderately severe jaundice involving the skin, mucous membranes and sclera. There were numerous scratch marks from the itching. The head, neck, chest and heart revealed no abnormalities. There was a scar in the anterior abdominal wall of an operative incision through the upper right rectus muscle. The liver was enlarged four centimetres below the costal margin. The spleen was readily palpable. There were no areas of tenderness. The extremities, reflexes and genito-urinary examination showed no abnormalities.

**Laboratory Tests.**—The icteric index ranged from 20 to 120 over a period of three weeks. The Van Den Bergh gave an immediate direct reaction and a positive indirect reaction. Blood count: Hæmoglobin 68 per cent, red blood-cells 3,100,000, white cells 9,000, polymorphonuclears 70 per cent. Urine: Trace of albumin. No sugar. Two plus indican. Two plus bile. Occasional hyaline cast. Kahn test Negative. Fragility test Normal. Bleeding time Sixteen minutes.

## FOREIGN BODIES IN BILE TRACTS

A diagnosis of common-duct obstruction the result of a cicatrix was made. The possibility of a carcinoma of the head of the pancreas was considered. Two blood transfusions of 800 cubic centimetres each were given over a period of a week and an operation was performed December 24, 1932.

*Operation*—Under ether anaesthesia the old right rectus scar was excised and the liver exposed. It was very dark and considerably enlarged. The common duct was buried in dense adhesions and was exposed with extreme difficulty. An incision in its lower portion exposed a black, spongy, somewhat friable mass. Its removal released a large amount of bile. The mass measured about one times one times five centimetres. It was sent to the laboratory. A good-sized catheter was sutured into the common duct, two Penrose drains were placed beneath the liver, and the wound was closed.

*Pathological Report*—Cotton gauze impregnated with bile, bile salts, and fibrin.

*Post-operative Course*—Large quantities of bile drained almost immediately from the catheter in the common duct. The jaundice improved rapidly, the urine became lighter, and the stool showed some bile. The course was fairly smooth and the prognosis favorable until the ninth day when some bleeding from the wound was noted. He had a slight chill and the temperature rose to 100°. The bleeding gradually increased until the wound partially separated and on the twelfth day the wound was packed in an attempt to control the hæmorrhage. The chills persisted intermittently and the temperature increased to 104.2° on the twelfth day. Blood transfusions of 800 cubic centimetres to 900 cubic centimetres were given on the second, seventh, and eleventh days. The jaundice increased rapidly from the ninth day until the thirteenth post-operative day, when death occurred. Unfortunately, no autopsy could be obtained.

*Comment*—The correct diagnosis as to the cause of the jaundice was not made until operation. No foreign body in the biliary tract ever had been encountered before and we were familiar with no criteria for such a diagnosis.

Sir Humphrey Rolleston,<sup>27</sup> in his book on "Diseases of the Liver, Gall-Bladder, and Bile Ducts," says in commenting on obstructive jaundice, "suspicion as to the nature of such foreign bodies must always arise unless the constituents of gall-stones has been definitely proved." It is rare that such a suspicion as a cause of obstructive jaundice is thought of.

It is perhaps more reasonable to be suspicious of a foreign body obstruction in the case of inexplicable jaundice arising soon after an operation on the biliary system. If the biliary system has been thoroughly explored one is familiar with the complications to be anticipated. If obstructive jaundice develops in an abrupt fashion, foreign-body obstruction must be included in the list of tentative diagnoses.

In very few of the reported cases was it mentioned that the possibility of a foreign body was considered. It is obviously a difficult diagnosis to make, particularly in those patients on whom no surgery has been done. There often is no history of any foreign body having been swallowed and if so, the symptoms occur after an interval late enough to cause no suspicion of a causal relation.

Most of the reported cases have appeared in the last twenty years, but one of the earliest reports was by Nauche,<sup>5</sup> who in 1878 found a steel needle in the gall-bladder.

Fruit seeds, cherry stones, and round worms were encountered years ago and are the foreign bodies mentioned in those text-books which consider

foreign bodies    Bullets, needles, thread, gauze, rubber tube drains—all have been found in the biliary tract

In 1914, a German soldier was shot in the upper right abdomen. Attempts to remove the bullet were unsuccessful. Fifteen years later Goldhan<sup>23</sup> operated because of severe pain. The bullet was found lodged in the cystic duct with the apex downward. His belief was that the bullet originally had lodged in the liver and had migrated downward by the hepatic duct.

Eastman<sup>6</sup> reports the presence of steel needles in the gall-bladder as the nuclei of gall-stones. Adhesions were present between the fundus of the gall-bladder and the pylorus. He believed the needles had been swallowed and had then passed directly from the pylorus into the gall-bladder. He thought this was the most logical explanation for the presence of fruit stones in the gall-bladder.

Many cases of recurrent gall-stones have been reported following cholecystostomy in which bits of suture material used in the first operation were nuclei for the gall-stones. Hall<sup>14</sup> mentions finding two unique worm-like stones in the gall-bladder three years following a cholecystostomy. A piece of suture ran the full length of each. This probably was the purse-string suture from the first operation.

Foreign bodies in the biliary ducts occur more rarely than in the gall-bladder. Oppel's<sup>17</sup> case is in many ways similar to ours. Four months after cholecystectomy, the patient developed a fatal peritonitis. At necropsy, a swab was found in the common bile-duct. There had been no incision made in the bile duct at the time of the cholecystectomy.

A patient of Cooke's<sup>19</sup> had neither jaundice nor colic but was operated on because of a greatly enlarged gall-bladder. Some stones were found in a distended gall-bladder and one in the cystic duct. From the common duct was removed a piece of bent, slightly corroded wire, one inch in length.

Federoff<sup>20</sup> describes an unusual accident while removing a T-shaped rubber tube drain from the common bile-duct of a patient. The stem of the T-shaped tube was discharged in the dressing and the horizontal part remained in the duct. Five months later the patient developed colic, jaundice and fever, but recovered and remained well for two and a half years when he had several similar attacks in rapid succession. Radiograms showed the drainage tube in about the same position but nearer the duodenum. A laparotomy was performed and the tube removed, five and one half years after the first operation. The patient made a complete recovery.

An insane woman reported by Lemierre and Pollet<sup>21</sup> swallowed the handle of a spoon. Apparently by way of the ampulla of Vater it penetrated into the common bile-duct and led to the development of diffuse liver abscesses.

Eichelter<sup>22</sup> found a piece of thread from a drainage strand of a former operation in the common bile-duct.

Some absorbable catgut ligature used in a cholecystectomy led to the development of a curious foreign body tumor with stricture of the common duct in a patient described by Hammesfahr.<sup>25</sup>

The mechanical explanations for foreign bodies arriving in the biliary system are as bizarre as the explanations for the course of migration of foreign bodies anywhere in the body.

It is logical to assume needles and other sharp objects that have been swallowed and reached the pylorus might migrate by direct contiguity into the gall-bladder. The curious circumstances that lead to such migration are difficult to visualize. Inanimate foreign bodies in the gall-bladder can hardly be explained on the basis of retrograde migration from the duodenum through the ampulla of Vater, but the motile round worms could easily reach the gall-bladder by this route.

## FOREIGN BODIES IN BILE TRACTS

A review of the reported cases would indicate that foreign bodies in the gall-bladder may be there for years giving rise to few symptoms as in the case of silent gall-stones. In the biliary ducts, however, colic, fever, and jaundice usually develop within a few months and lead to operation.

*Conclusion*—A case is reported of common bile-duct obstruction by gauze following cholecystectomy and the literature reviewed. The necessity for the inclusion of possible foreign-body obstruction as one of the tentative diagnoses for the cause of jaundice following cholecystectomy is suggested.

### TYPES OF FOREIGN BODIES IN BILIARY TRACT

(1) *Cystic Duct* (Rifle Bullet) Shot in right abdomen in 1914. Operated by Goldhan<sup>23</sup> in 1929. Thought that bullet entered liver, then hepatic duct to cystic duct.

(2) *Gall-Bladder* (Seeds and Worms) (Mertens,<sup>2</sup> Deaver,<sup>3</sup> etc.) (Steel Needles) (Nauche<sup>4</sup> and Eastman<sup>5</sup>) Thought to have been swallowed, then migrated to gall-bladder from pylorus. (Calculi Following Surgery) Recurrent stones with pieces of suture used at former operation as nuclei. (Homans,<sup>7</sup> Kehr,<sup>8</sup> Malcolm,<sup>10</sup> Drummond,<sup>11</sup> Florcken, H,<sup>12</sup> Hall<sup>14</sup>) (Bristle and Piece of Thread) (Haughton<sup>13</sup>) (Gauze) (Bevan<sup>17</sup>) Removed after interval of eleven years. (Rubber Drain) (Schulze<sup>16</sup>)

(3) *Biliary Ducts* (a) (Common Duct) swab found four months after cholecystectomy. Common duct had not been opened so probably had migrated from peritoneum (Oppel<sup>17</sup>) (*Piece of Wire*) Swallowed and migrated to common duct. (Rubber Drain Tube) (Federoff<sup>20</sup>) (Handle of Spoon) Swallowed by insane woman (Lemierre and Pollet<sup>21</sup>) Produced diffuse liver abscess. (Non-Absorbable Catgut Ligature) Stricture of common duct by foreign-body tumor forming around catgut. (Homans<sup>7</sup>)

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# ACUTE SURGICAL LESIONS OF THE PANCREAS

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THE treatment of acute surgical lesions of the pancreas must depend upon the etiological factors producing the pathological conditions present. It has been recognized that there is a direct relationship between disease of the biliary system and various pancreatic lesions, but just what is this relationship in the different lesions found, and how the biliary disease affects the pancreas is far from being clarified. Even the nomenclature of the disease is a subject of confusion. The lesions are variously reported as acute pancreatitis, acute hæmorrhagic pancreatitis, subacute pancreatitis, œdema of the pancreas, pancreatic necrosis, or chronic pancreatitis. No one term seems to fit all cases, and chronic pancreatitis is included here because what appears to be a minor or chronic lesion of the pancreas may be found at an operation for cholelithiasis or cholecystitis. Then, after what is believed to be the proper form of surgical operation is performed, the patient dies within a few days, and at autopsy the most severe form of necrosis and disintegration of the pancreas may be found.

It has been stated that the mortality has been very little reduced over a period of years. Korte, in 1911, reported 103 cases with 60 per cent mortality. Schmieden and Sebening, in 1927, collected 1,278 cases with 51.2 per cent mortality. However, a statistical study of this condition would appear to be of somewhat questionable value because of the varying type of lesions which would be included in such a group of cases.

Operations for acute lesions of the pancreas are not sufficiently common for any one surgeon to have a large enough number of cases to form definite conclusions from his personal experience. In order to get a more definite idea of the disease, all of the cases diagnosed under the heading of acute lesions of the pancreas occurring during the last fifteen years at St. Luke's Hospital were studied. This further confirmed the belief as to the difficulty of reaching definite conclusions from a statistical viewpoint, because of the great variety in description of the pathological lesions found at the time of operation, subsequent histories of patients after operation, pathological conditions found on readmissions or reoperations and findings at autopsies on the patients who died. It was equally difficult to correlate the relationship between the various lesions found in the biliary system and the condition of the pancreas. Although in the vast majority of cases there appeared to be a distinct relationship between biliary disease and the pancreatic lesion, there were a few cases in which there were no gall-stones or gross evidence of biliary disease.

It is unnecessary to review in any detail the various studies as to the



etiology of pancreatic disease since Claude Bernard, in 1856, reported that in animals the injection of certain substances into the pancreatic duct would cause various degrees of acute pancreatic necrosis, which, if severe enough, would result in the death of the animals. Bile mixed with olive oil was used by Bernard. Since then, various other substances have been used in experimental work. Opie, in 1901, correlated this experimental work with a report of an autopsy on a patient dying of acute pancreatic necrosis where a small gall-stone had obstructed the ampulla of Vater. This was followed by other experiments, unnecessary to mention, until Archibald linked up certain other factors, such as the introduction of infected bile, under just sufficient pressure not to overcome the sphincteric action of the sphincter of Oddie, whereby he could cause varying degrees of necrosis of the pancreas. He also enumerated a group of factors, the necessity of the presence of which makes understandable certain conditions in the causation of the disease which would otherwise be hard to explain. These three factors were: First, the changes in the composition of the bile, due to infection, which increases the proportion of bile salts; second, undue resistance, perhaps often amounting to spasm of the common-duct sphincter; and third, abnormal rise of pressure in the biliary system, either in the gall-bladder or common duct.

To add to the confusion of thought, the theory of infection of the pancreas by means of retrograde infection through the lymphatics from the gall-bladder, appendix or a duodenal ulcer has been advocated by Bartels, Arnsperger, Franke, Deaver, Pfeiffer and Sweet. Contradictory evidence appearing to apparently invalidate in certain instances all of the various theories can be instanced, such as a case report of White and Owen in which a carcinoma, extending from the stomach, so dilated the duodenum and the sphincter of Oddie that it allowed free flow of the duodenal contents—bile and pancreatic juice—into the pancreatic duct without any particular change in the pancreatic tissue. It is also a fact that at autopsy the pancreas may be found apparently bile-stained without a necrotic condition occurring. On the other hand, the theory of infectious origin of acute pancreatic lesions would seem to be contradictory of the fact that, although in some cases one finds enlarged lymph-nodes about the common duct and head of the pancreas, the type of lesion found does not coincide with original infectious processes elsewhere and cultures made at the time of operation are nearly always sterile. Furthermore, when a patient recovers without an operation and a residual lesion occurs, instead of occurring as the usual type of abscess, which one expects to find in an infective process, it occurs as a cyst or as an area of fibrosis in the body of the pancreas, surrounding a softened, cheese-like material which is not pus.

Numerous cases are reported where a reflux of bile could not have been the etiological factor because the necrosis appeared to be primary about the duct of Santorini, which entered the duodenum separately from the combined orifice of the duct of Wirsung with the common bile-duct at the papilla. And even where they entered together, the anatomical arrangement in a large

percentage of cases would not allow biliary reflux. An influx of duodenal fluid might have been the etiological factor in these cases as it has been shown that the injection of duodenal fluid will cause pancreatic necrosis, but, experimentally, this duodenal fluid injection must be made under pressure.

The symptomatology and diagnosis of the acute lesion of the pancreas has been admirably reviewed recently by deTakats and MacKenzie in an article published within the last year in the *ANNALS OF SURGERY*. It is not necessary to repeat this work here, beyond calling attention to the fact that in the twenty-two cases reported by them, the diagnosis of acute pancreatic necrosis was not made in one single instance. The most common diagnosis was acute cholecystitis or common-duct stone and there was present an incidence of biliary infection in eighteen of the twenty-two cases, which gives 81.2 per cent of biliary infection as a primary cause of the pancreatic pathology. DeTakats also calls attention to the value of the determination of diastase in the blood and urine as a diagnostic aid. He quotes "Skoog states that while increased values may occur in other acute abdominal conditions, a negative finding, provided that determination is made within twenty-four hours to thirty-six hours after the onset of symptoms, excludes any pancreatic pathology."

A review of the histories of thirty-two cases of acute pancreatic necrosis occurring during the last fifteen years in St. Luke's Hospital has not enabled me to reach any more definite conclusions than I had before such examination. However, there were many observations which did appear to have a distinct bearing on the etiology, pathology, progress and treatment of the lesion present.

(I) It was observed that a number of patients gave histories of previous attacks of upper abdominal pain, previous to their severe attack for which they entered the hospital. (deTakats and MacKenzie report this in nineteen out of thirty cases.) At autopsy on a patient who died following an operation for acute pancreatic necrosis, an area was found at the junction of the body and tail of the pancreas where there was an area of fibrosis surrounding cheese-like material, evidently a result of a previous attack from which the patient had suffered a year earlier and which had been diagnosed as a gall-stone attack. This further demonstrates the possibility of recovery without operation from a rather severe lesion.

(II) There were several patients upon whom an operation was performed for cholecystitis with cholelithiasis or common-duct stone on whose histories the pathological finding, reported at operation, stated that the pancreas was thickened, sometimes moderately in the region of the head, and other times enlarged to two or three times its natural size. In these cases there were usually also observed varying degrees of fat necrosis. Several of these patients after drainage of their common duct, or cholecystostomy, died, and at autopsy a severe degree of pancreatic necrosis, with destruction of the pancreas, was found.

(III) A number of patients in whom only moderately severe lesions were found at the time of operation went on to develop secondary lesions in the pancreas. One patient who had upper abdominal symptoms for six weeks before admission to the hospital, with a history of a severe attack three years previously, was operated upon. The gall-bladder was found to be microscopically normal, there were some areas of fat necrosis and the whole pancreas was hard with no areas of softening. Nothing was done

beyond the exploratory operation. Three weeks later the patient had developed a cyst of the pancreas from which a quart of fluid was evacuated. Another patient who at operation showed fat necrosis with red and greenish areas in the pancreas and a shrunken gall-bladder containing small stones, whose operation consisted of drainage of the pancreas with nothing being done to the biliary tract, recovered from the operation but was readmitted four years later with similar symptoms. An X-ray showed a calcified area in the left upper quadrant of the abdomen, 2.5 centimetres in diameter, which was apparently a calcified cyst in the pancreas. Another patient who had been operated upon for acute pancreatic necrosis in another hospital six years previously subsequently developed three attacks two years apart, during the first and third of which a pancreatic cyst was drained.

(IV) One patient was admitted to the hospital and died in diabetic coma, with a blood-sugar of 840. Autopsy showed hæmorrhages into the pancreas with nothing abnormal in the biliary system.

(V) A patient upon whom a cholecystectomy was done two years previous to readmission had a pancreatic cyst drained and subsequently died from hæmorrhage due to erosion of one of the larger blood-vessels in the region of the pancreas.

(VI) A group of cases who were apparently cured, or discharged from the hospital improved, and readmitted at varying times thereafter, were of special interest. One of them was discharged from the hospital with the wound healed in January, 1920. At the time of operation the head of the pancreas was the size of an orange and there was one gall-stone. A cholecystoduodenostomy was done. Eight years later the patient was readmitted to the hospital with a diagnosis of perforated gastric ulcer. At operation the pancreas was found swollen, hæmorrhagic and soft. Drainage to the pancreas was established, and at autopsy the pancreas was found necrotic throughout. Another patient was operated upon with a pre-operative diagnosis of cholelithiasis. The pancreas was hard with some hæmorrhage and fat necrosis. Stones were present and a cholecystostomy was done. The patient was discharged one month after operation and readmitted a month later with pain and a temperature elevation. Twenty days later the patient went into shock and had extensive hæmorrhages from the stomach and intestine, and died. Another patient was operated upon for acute pancreatic necrosis twenty-eight hours after admission. There was fat necrosis in the abdominal wall and peritoneum, and stones in the gall-bladder. A cholecystostomy was done and the posterior layer of peritoneum over the pancreas split and drained. The pancreas was soft and mushy. The wound drained for three months and the patient was discharged from the hospital. She was readmitted two weeks later in collapse and died within twenty-four hours. At autopsy stones were found in the common duct, one being in the ampulla of Vater. There was fat necrosis down to the pelvis, scar tissue in the head of the pancreas and a large cyst in the tail. Another patient was operated upon in another hospital for acute pancreatic necrosis with drainage to the pancreas. The patient was admitted to St. Luke's Hospital seven months later with symptoms of vomiting, peripheral neuritis and tetany. The patient suddenly had an attack of acute upper abdominal pain and died within a few hours. Autopsy showed a normal gall-bladder, the pancreas bile stained, the tissue hard and shotty, regional lymph-nodes enlarged and fat necrosis. Another patient was admitted in January, 1931, with cholecystitis and jaundice and refused operation. The patient was readmitted three months later and operated upon for cholelithiasis and common-duct stones. The patient improved immediately after operation, but died on the twenty-first day. Autopsy showed the pancreas bloody and gangrenous. There were also duodenal ulcers and gangrene of the duodenum found at the autopsy on this patient. Another patient was admitted with a diagnosis of chronic cholecystitis. He refused operation, was discharged and readmitted six months later with a history of fever, jaundice and pain. A diagnosis was made of stone in the common duct. At operation, a shrunken gall-bladder which contained seven stones was found. The pancreas was hard, there was no fat necrosis and the common duct appeared to be normal. The

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common duct was drained and the patient died nine days later. At autopsy, the pancreas was firm and swollen and fat necrosis was present. The liver was soft and green, as is usually found in those cases which die from a liver death.

(VII) There were three patients who, after cholecystectomy for cholelithiasis, had epigastric or left hypochondriac pain of varying degrees, which was believed by the operator to have been mild attacks of pancreatitis.

(VIII) Of the whole group of cases, only one showed obvious evidence of infection such as occurs in other parts of the body. This patient was in the medical ward with a diagnosis of portal thrombophlebitis. An exploratory laparotomy was performed, after transfer to the surgical ward, but no operative procedure was done. At autopsy, portal thrombophlebitis and abscesses in the liver and pancreas were found. There were no stones in the gall-bladder or common duct. The pancreatic duct was larger than normal.

(IX) One patient was admitted with a diagnosis of acute cholecystitis and general peritonitis of forty-eight hours' duration. She had an attack, with jaundice, six months previously, and died within twenty-four hours of admission to the hospital without an operation. At autopsy, the whole pancreas was firm, green or red and swollen. The common duct was full of stones. There was fat necrosis in the peritoneum and pleura. This was the only case in which fat necrosis was found to have extended beyond the peritoneal or pelvic cavities or the abdominal wall.

(X) One patient was of particular interest in regard to the question of the value of biliary drainage. She was operated upon after a two-days' history with a pre-operative diagnosis of gall-stones. The pancreas was hard and indurated, there was fat necrosis, and some fluid in the peritoneum. The stones were removed from the gall-bladder and a cholecystectomy was done. The patient's convalescence was uneventful until three weeks after operation, at which time there was a second attack after the bile had stopped draining from the gall-bladder. After re-establishment of the drainage the symptoms disappeared and the patient recovered.

(XI) One patient was operated upon for an appendiceal abscess and developed a fecal fistula two days after operation. Five days after operation the patient developed severe pain with vomiting and was believed to have a perforated gastric ulcer or acute cholecystitis. At a second operation there was a large amount of fat necrosis and a mass in the region of the pancreas, but, because of the large amount of fat in the abdominal cavity, adhesions and thick, short mesocolon, the mass could not be explored or the gall-bladder felt. The patient died in nine hours and no autopsy was done. This was the only case in which an acute pancreatic necrosis appeared to be related to an infection secondary to anything outside of the biliary system, but infection of the biliary system could not be excluded.

(XII) One patient seen previous to the time included in this group developed symptoms of acute pancreatic necrosis followed by a mass in the epigastrium, evidently a pancreatic cyst, refused operation and recovered completely before leaving the hospital. This supplements the patient mentioned above, who had developed three pancreatic cysts after operation and who recovered spontaneously from the second cyst only to have it recur two years later.

(XIII) One patient entered the hospital with a diagnosis of acute cholelithiasis and cholecystitis. Previous to operation, a rectal examination resulted in the finding of a gall-stone in the rectum. At operation a few days later, at which time the gall-bladder containing a second stone was removed, the pancreas was found hard, indurated, oedematous and at least twice its normal size.

(XIV) Another patient was operated upon, previous to this group of cases, for an inflammatory tubo-ovarian condition. At operation fat necrosis of the omentum was found and examination of the pancreas showed it to be hard, indurated and mottled green and red in color. She had shown no symptoms calling attention to the pancreas or biliary system.

The group of cases studied at St Luke's Hospital numbered thirty-two after excluding all of those cases which were diagnosed as chronic pancreatitis, only those in which an acute lesion was found, either at operation or at autopsy, being considered. Of these, thirty were operated upon. Fifteen died and fifteen recovered. Two patients died without operation, but the diagnosis was confirmed at autopsy. Two cases were diagnosed as acute pancreatic necrosis, two as perforated duodenal ulcer, two as acute intestinal obstruction, and most of them were diagnosed as acute cholecystitis or, when jaundice was present, stone in the common duct. In the latter group the diagnosis was confirmed, the pathological condition of the pancreas being secondary to the biliary lesion. The pancreatic cyst cases were correctly diagnosed.

*Comment*—While there is, apparently, an operative mortality of 50 per cent in these thirty cases, as before stated, a statistical study of mortality and symptomatology cannot be of much value. In many of these cases, which were operated upon with a diagnosis of cholelithiasis and cholecystitis or stone in the common duct, the pancreatic lesion varied enormously, and in some, where the pancreas appeared to be severely damaged, the patients recovered. In most of them, drainage of the biliary system, either by the gall-bladder or the common duct, was instituted. In others, for certain reasons, nothing was done to the biliary tract. Some of them died regardless of the operative procedure. To me, one of the most interesting observations was the fact that in a very considerable number of cases the lesion in the pancreas was described as a thickening in the region of the head of the pancreas, resembling what is usually described as a chronic pancreatitis, but, in practically all of these cases, there were some areas of fat necrosis present. A very considerable percentage of these cases died subsequent to a cholecystostomy or a choledochostomy. An autopsy showed that the mild lesion of the pancreas found at operation had progressed to an acute pancreatic necrosis with extensive destruction of the pancreas. There were other cases in the group of histories studied—which are not included in this series—in which the pathological description of the condition of the pancreas was almost the same as in this group of fatal cases, except for the absence of fat necrosis. These cases were called on the diagnostic cards chronic pancreatitis. If these cases, as most of them recovered, were included in the series reported it would change the mortality rate entirely.

A study of these cases is also of interest as bearing on the question of the etiology and pathology of the various pancreatic lesions. The facts presented may be considered in the light of presumptive evidence, as there is little to be advanced in any direction as conclusive proof. In the vast majority of cases, gall-stones and usually a cholecystitis were present. A few patients had stones in the common duct and in one patient an impacted stone was found at autopsy, and in another patient a stone was found in the rectum which obviously had recently passed through the common duct, and it may be assumed that there was some temporary blocking at the ampulla of Vater.

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In three of the cases there was no evidence of gall-stones, although there was a pancreatic lesion. As pertaining to the lymphatic theory of infection of the pancreas, in only one case was recorded the finding of markedly enlarged glands about the head of the pancreas, and in none of the early cases where a culture was taken was there any evidence of growth on the culture medium (anaerobic cultures were not made).

Several cases demonstrate the fact that various pancreatic lesions occur from which the patients may entirely recover without operative treatment only to have subsequent attacks of greater severity, or develop a cyst. With operative treatment, whatever may have been done, a mild lesion found at operation may progress to a fatal termination. The favorable influence of biliary drainage was, apparently, demonstrated in one case where, when drainage ceased, the symptoms appeared to become worse only to retrogress when drainage was re-established. Whether patients in whom biliary drainage was instituted and subsequently died already had enough damage to their pancreas to cause the pathological condition to progress, or whether interference with the biliary system caused an immediate increase in infection and thus a change in the bile, with diminution of mucin which lessens the bile's irritative action, is difficult to determine. These facts bring into question the value of biliary drainage as a curative procedure. It is demonstrated in this series of cases that even with a severe pancreatic lesion the patient may get well without an operation and that certain other patients who have an operation for a mild lesion will die, due to a progressive extension of the pathological process. It is also demonstrated that certain severe cases will die without operation, as shown by two of this series which were proved by autopsy. It is further demonstrated that cysts of the pancreas, which vary from a small, fibrosed area containing a cheese-like material, to a cyst containing a quart of turbid, yellow fluid, may form in from seventeen days to several months after an acute lesion and may then require operation or may spontaneously disappear entirely or may become calcified.

The value of a cholecystectomy as a curative therapeutic procedure, while not disproved, at least is made dubious by the history of the patient who developed a pancreatic cyst which progressed and increased in size two years after a cholecystectomy was done, but in this instance the damage to the pancreas had already occurred and there was no new acute attack. The possible relationship to an appendicular infection, which frequently is mentioned but seldom proved, might be instanced in considering the patient who, five days after an operation for an appendiceal abscess, developed an acute pancreatic necrosis, but, in this case, the gall-bladder could not be examined.

In only one case was there infection such as is found elsewhere in the body. This case, which is not included in the series of acute pancreatic necrosis as it obviously falls under a different heading, was the one having multiple abscesses in the pancreas and liver and where the etiology was a portal thrombophlebitis.

There was fat necrosis, in varying degrees present in all of these cases

except one. It varied from small, minute areas in the fat or omentum about the pancreas, to more extensive necrosis throughout the peritoneal fat. In two patients, it extended to the pelvis, in one, to the abdominal wall, and at autopsy on a patient who died without operation, it was found in the lung and pleura. At autopsy, on a case operated upon by me previous to this series—when it was considered proper surgery to drain into the broken-down pancreas—it was found that the pancreatic leakage had obviously caused extension of the fat necrosis all through the retroperitoneal tissues down into the pelvis. This, in addition to other reasons, seems to me to be sufficient proof that the old method of pancreatic drainage was bad surgery.

An attempt to formulate a symptomatology or diagnostic criteriae which would include all cases of acute pancreatic necrosis would be futile unless they were divided into the two main groups into which such cases fall. These are—first, the occurrence of a major upper abdominal catastrophe, in which the differential diagnosis must be made from a perforated duodenal or gastric ulcer, an acute intestinal obstruction or a rapidly developing peritonitis. The second group are those in which symptoms of an acute biliary lesion predominate, with the pancreatic pathology as a secondary development. Even this grouping would omit the occasional case where the lesion is mild and without definite symptoms.

In the first group, if there is severe upper abdominal pain, radiating to the back, an acute pancreatic necrosis must be considered. In a very considerable number of cases a history of previous attacks, suggesting biliary disease, may be elicited from friends and relatives if the patient is too sick to give a history. A flat X-ray film to help rule out a perforation or to demonstrate localized distended intestine may be of negative value, as is the loss of liver dulness. A patient with early pancreatic necrosis usually writhes about in bed because of pain. With a perforation he lies quietly because of peritoneal irritation. In the former, at the beginning of the attack, there is absence of rigidity. Later, rigidity appears with the appearance of "beef broth exude" and peritoneal irritation. Vomiting, pulse rate, temperature, urine examination and blood count might be those of any acute abdominal lesion, but not definitely diagnostic, except that the blood count might differentiate an intestinal obstruction from an inflammatory or necrotic lesion. A high blood-sugar and high diastase values in the blood or urine are also of differential diagnostic value. In the acute fulminating cases, X-ray examination with a barium meal is impractical but in the more slowly developing cases, with the slow development of an enlargement of the head of the pancreas or a cyst, this condition may frequently be demonstrated.

In the group of cases where biliary symptoms predominate, either as jaundice or as signs of an acute cholecystitis, the fact that the pancreatic damage, from a slight to a very severe degree, may occur in a small but very definite percentage of cases must be kept in mind. This was well demonstrated in the group of cases reviewed and perhaps in patients falling into this classification, who complain of pain and tenderness in the epigastrium

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and left hypochondrium, in addition to their biliary symptoms, a high or increasing blood-sugar or diastase values in the blood and urine might be an indication of progressive pancreatic injury. While it is stated that the primary influx into the pancreatic duct causes the immediate maximum damage, the examination of the above recorded cases would appear to demonstrate that the irritating factor may be repeated. This, it would seem, has an important bearing on the operative treatment. And, while it is accepted that an acute pancreatic necrosis is an uncommon sequel to a biliary infection, it is not unusual to find some thickening in the head of the pancreas accompanying gall-bladder or common-duct pathology. The small number of autopsies or secondary operations in this series of cases has demonstrated that this pancreatic lesion may progress. It is my belief that this should be considered in the application of a universal rule for delay in all acute gall-bladder cases.

The surgical management of pancreatic necrosis must depend on whether one is dealing with an acute fulminating case or one in which the symptoms are due mainly to disease of the biliary system. The patient with the acute fulminating lesion is in shock and is a very bad operative risk. One such patient, in the series examined, died on the table. Operation should be postponed until suitable treatment for the shock, especially with glucose intravenously and hyperdermatically, has been instituted. Occasionally, such acutely ill patients are operated upon when the exact diagnosis cannot be determined, especially if a perforation is believed to exist.

Any standard operative procedure would be difficult to formulate. Many of the more severe lesions will cause death, either with or without operation. When extensive damage of the pancreas has occurred, it is necessary to drain down to the pancreas. At operation it may be impossible to tell how far this destruction may go. Cases are on record where practically the whole pancreas has been extruded as a slough. One such case was reported recently, with recovery of the patient. Therefore it is necessary to provide for the possibility of this occurrence, as well as to allow for the escape of split proteid products which are of a toxic nature. Such drainage should be provided for by a rubber dam. A tube should not be used. Patients may die of late secondary hæmorrhage from erosion of the large vessels in the mesocolon or about the pancreas. This would be more apt to ensue if rubber tubes were used as they may cause pressure necrosis. The question of biliary drainage depends upon the acceptance of the theory of biliary influx into the pancreas as an etiological factor. The evidence seems to strongly favor this. If one accepts the theory that the maximum damage is effected by the primary influx of changed bile, such drainage would, theoretically, be ineffectual, but the evidence of the group of cases examined would seem to prove that this influx can be repeated. Consequently, drainage should be instituted. This is most easily effected by cholecystostomy. If there are stones in the common duct these should be removed, but this is not always effectual, as is amply proved by the progression and recurrence of lesions after institution of biliary drain-



age An extensive operation cannot be done when the patient is very ill. Theoretically, one should establish the fact that the common duct is patent into the duodenum, but probing of the common duct may cause swelling and œdema from traumatism at the ampulla of Vater, and thus increase the possibility of reflux of bile. This leaves the matter of operative procedure one that should be determined largely by the pathological condition found. It has been suggested that a cholecystectomy would be the ideal procedure, first by the removal of the focus of infection and thus the elimination of one etiological factor, that is, the change in the bile with its increased bile salts, which occurs with infection, and second by causing dilatation and relaxation of the sphincter of Oddi, which occurs after cholecystectomy. But, before this dilatation and relaxation occur, unless drainage is also instituted, pressure in the common duct is increased, which would more likely result in reflux into the pancreatic duct, if anatomical conditions were such as to allow this. Furthermore, the less that is done to such a seriously ill patient the better the prospect of recovery.

It might be expected that with the extensive damage to the pancreas, there would be more evidence of failure of its function, as shown by elevation of the blood-sugar, but it is surprising in many instances how little there is of this symptom. In some cases, however, there is sufficient impairment of function to make the use of insulin of considerable value in the post-operative treatment.

The recurrence of attacks, often of a severe or even fatal nature, after recovery from an operation for acute pancreatic necrosis where biliary drainage has been instituted, would seem to indicate that it would be good surgery to remove the gall-bladder in these patients as a prophylactic against further pancreatic damage after their recovery from the primary attack.

BLOOD CYST OF THE SPLEEN  
(INTRACAPSULAR RUPTURE)  
By FREDERIC N G STARR, FRCS (CAN)  
OF TORONTO, ONTARIO

IN JULY, 1928, a boy aged ten years was brought to my consulting-room His mother had noticed him "standing crooked" He was pale and undernourished but very active He did not stand up straight but canted over to the left  
Upon examination there was discovered a large mass in the left upper abdomen, the lower border of which was smooth and rounded, the notch not palpable, and extended



FIG 1—Cyst of spleen with portion of wall removed to show inner lining  
(One half actual size)

to the level of the umbilicus There was dulness on percussion up to the level of the seventh rib on the left side in the mammary line The lump moved with respiration Upon turning him on his right side, the tumor moved to the mid-line In this position I could elicit fluctuation He weighed seventy-five pounds

A pyelogram was made and the kidney was found to be normal but displaced downward. The blood smear was normal, the white count only 7,000.

There was a history that two years previously he was playing hockey in the school yard and when dodging another boy he struck the left side of his abdomen against a post. He was "knocked out" for a few minutes. After that, not feeling like any more hockey, he went home. He felt seedy and lay about the house for a few days, then he returned to school and carried on as before, taking part in the play with the other boys, and gradually getting into shape so that one day he might qualify for a post on one of the so-called American hockey teams.

He again presented himself in November and the tumor was larger. I advised operation. Preparatory to this, on November 26, 1928, he was given a blood transfusion. On the following morning the abdomen was opened through a left rectus incision. Some adhesions between the left lobe of the liver and the splenic tumor were encountered and

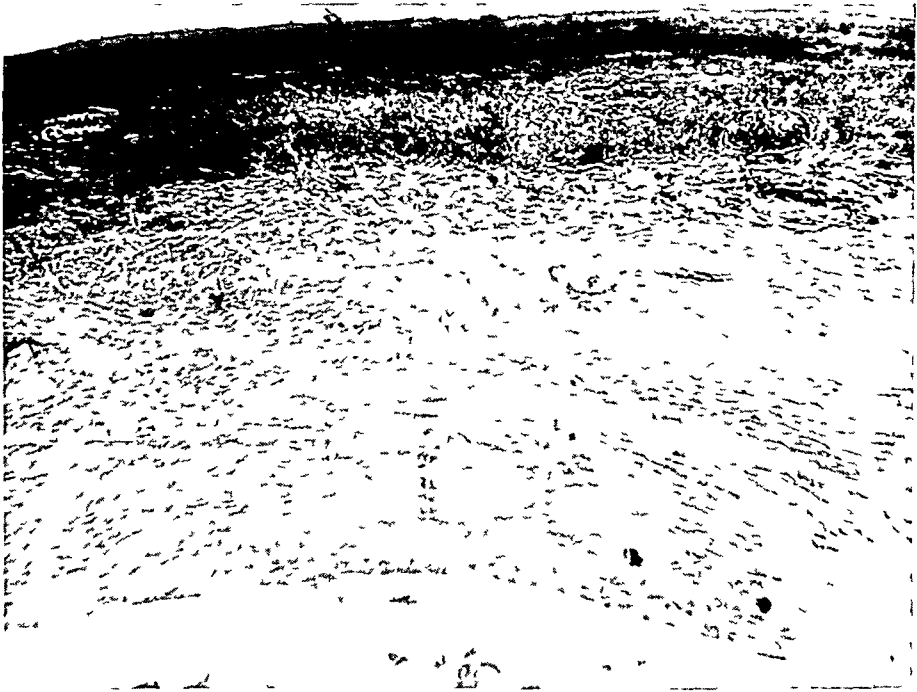


FIG 2—Section through cyst wall showing splenic capsule, remnants of splenic tissue and dense hyalinized cyst wall proper (X100)

divided, and some adhesions to the posterior parietal peritoneum were also divided, and the tumor delivered. The pedicle was then clamped, the spleen removed and the pedicle sutured. Other bleeding points were secured and ligatured or sutured. The boy made an uninterrupted recovery, returning home on the seventeenth day.

I saw him again in the following April. He was very well, eating, sleeping, and playing like a normal child, and had gained nine pounds in weight. His health has continued to be excellent.

The inference is that when he struck his left side two years previously he sustained an intracapsular rupture of the spleen, which accounted for this ultimately becoming a blood cyst containing degenerated blood. It is known that such cysts occasionally occur from an infarct in the spleen, but in this case there was no history of a previous illness up to the time he met with injury. I have been able to find but few references to this type of splenic tumor, but several cases have been reported.

Dr W L Robinson, the pathologist, reports upon the specimen as follows:

The spleen was moderately enlarged, measuring 18 by 13.5 by 5 centimetres.

## BLOOD CYST OF SPLEEN

The capsular surface was smooth, tense, and glistening. The organ had been almost entirely transformed into a large thin-walled cystic structure and was quite fluctuant on external palpation. On opening the cyst about one quart of rather thick reddish-brown fluid material flowed out freely. The greater portion of the wall measured about two millimetres in thickness, other portions of it being extremely thin and semitranslucent. It was lined by soft masses of partially coagulated blood. On removing these clots the wall presented a smooth, glistening but coarsely trabeculated appearance.

Microscopical sections taken through the wall of the cyst show the latter to be made up of a thick layer of mature fibrous connective tissue rich in collagen. Much of this is of a homogeneous and relatively acellular appearance. Adhering to the inner lining (Fig 1) are masses of platelets, fibrin and red blood-cells. Toward the inner margin are numbers of endothelial cells laden with hemosiderin pigment, together with considerable amounts of recently extravasated blood. A few scattered lymphocytes are observed between the connective-tissue bundles. In the more dense portions of the wall are focal deposits of iron and calcium. Between the capsule (Fig 2) of the organ and the fibrous wall of the cyst very small remnants of splenic tissue were found.

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# SURGICAL JUDGMENT IN THE APPROACH TO THE ACUTE ABDOMEN

BY LE GRAND GUERRY, M D  
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WE ARE constantly drawing this distinction between an operator and a surgeon defining an operator as one who is concerned primarily with problems of method and technic, or, as it were, the ritual of surgery. Such a person is not greatly concerned with the broad fundamental principles of medicine that underlie the practice of good surgery.

On the other hand, we like to think of a surgeon as one who has been broadly educated, who possesses philosophical background, who is more concerned with principles than with the technic of method, who understands that the basis of good surgery is good medicine, who has mental capacity and grasp to deal with the spectral doubts that lie outside of the operating room, and who understands when and where to operate as well as how to operate.

This is just another way of saying that we intend to discuss for the few moments at our disposal the subtle problem of judgment, specifically, surgical judgment. Just at this point it may be well to define judgment in the language of Webster. "The word judgment has its derivation from the Latin word *Judicare* and is defined as 'The act of judging, the operation of the mind, involving comparison and discrimination, by which a knowledge of moral qualities, intellectual concepts, logical propositions, or material facts, is obtained. The power or faculty of performing such operations when unqualified, the faculty of judging or deciding rightly, justly, or wisely, good sense'."

To my thinking it is impossible to discuss properly the approach to the acute abdomen without a consideration of surgical judgment since the two things are well-nigh synonymous terms. The reason for this is not far to seek. The mistakes of surgical judgment in handling the great crises of the acute abdomen can be quickly turned into fatalities. The fate of these cases depends, not primarily on a technic and method of operation, but are indissolubly connected with clear, precise, discriminating judgment.

The surgeon who properly correlates his facts, wisely interprets them, who uses the clearest judgment in the application of these facts to the individual case, will always have the best results. This is a principle that is germane to the whole range of human thought and action. It is true in business, it is true in law, it is true in general medicine, it is true in surgery.

This is the reason, certainly one of the reasons, why problems of judgment so vastly outweigh in importance methods of technical performance.

Sir Frederick Treves, one of the keenest and most philosophical minds

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in the field of surgery, has given us this aphorism "Shakiness of the hand may be some bar to the successful performance of an operation, but he of a shaky mind is hopeless"

To illustrate An ordinary supravaginal hysterectomy for an uncomplicated uterine fibroid tumor in an otherwise sound and healthy woman does not call for the exercise of any special amount of judgment, it is a conventional operation, with ample time not only to prepare the patient, but to fix and determine the conditions under which the operation shall be done It becomes at once obvious in such a case that method of operating and technic of performance take the position of primary importance

How vastly different is the problem, however, in the case of a man with a bullet wound through his abdomen When you see him for the first time he is in profound shock, with a feeble rapid pulse, cold clammy leaky skin, subnormal temperature, cyanosis, air hunger, and probably intraperitoneal hæmorrhage The threshold of his vitality and resistance has been forced down to the lowest possible level, well-nigh anything done to him would be enough to push him over

How are you going to handle such a case? Take him to the operating room and operate immediately? I think not For this situation imposes on us not only difficulties of handicraftsmanship, but the far weightier problem of when to interfere Surely the patient would be better off to take sufficient time to improve his general condition Namely by getting him warm, by giving him sufficient morphine to relieve his pain, by raising his fluid level, by giving him time to react from the primary shock of the injury, by blood transfusion, *etc*

One of the most serious problems in connection with the acute abdomen, particularly so and always present in the matter of penetrating wounds, is the question of hæmorrhage It is serious enough to be responsible for a large number of deaths from this source Many of these patients die from hæmorrhage long before the stage of peritonitis has been reached Our position about the surgical handling of such cases may be stated as follows We believe it to be a great mistake to take these patients with penetrating, perforating bullet wounds of the abdomen that arrive in a condition of profound shock, with or without hæmorrhage, rush them to the operating room and operate immediately If you do so you are inviting disaster and an excessively high mortality Specifically as regards the problem of hæmorrhage we must remember that in the presence of traumatic shock it takes comparatively little loss of blood to produce a profound circulatory disturbance

Often we have had this experience In cases of perforating wounds of the abdomen with hæmorrhage, we have operated on and repaired ten or twelve perforations, practically emptied the abdomen of blood and completed the operation without finding the source of hæmorrhage An irregular tear in a small vessel coupled with a profound drop in blood-pressure permits thrombosis of the vessels thereby controlling the hæmorrhage before the

operation is undertaken. This is one of the main reasons why we never operate with precipitate haste. On the other hand, proponents of immediate interference will occasionally take part in the dramatic episode of saving a life by finding and controlling the bleeding from a larger vessel. In so doing, however, they will sacrifice ten lives for the purpose of saving one. We believe this to be bad surgery.

Let me repeat, as indicated above, much of the time through the operation of natural forces the bleeding will already have stopped.

And remember this—that even in the presence of a perforated intestine, it takes time to develop a spreading peritonitis. There may be immediate local soiling but not a true peritonitis. This takes time to develop, several hours of time at that. In many cases you have ten or fifteen hours in which operation can be deferred with advantage.

Some years ago I published a paper on “Penetrating Gunshot Wounds of the Abdomen” in which there were reported twenty-seven cases with a mortality of about 10 per cent. I am perfectly convinced that a number of these cases were saved by taking the necessary time to improve the patient’s condition before operating.

To illustrate. A woman, aged thirty-seven years, with an infected gall-bladder with stones, was operated on December 4, 1931. Operation was the conventional cholecystectomy which was readily accomplished without any undue difficulty. She left the operating table in excellent condition. There was no problem up to this point to tax one’s judgment or surgical resource. What an amazing difference to find the patient on the same afternoon about 5 o’clock *in articulo-mortis* from an intra-abdominal hæmorrhage. Surely, here we were in the presence of a real emergency. The customary thing to do under such circumstances would be to give the patient an anæsthetic, reopen the abdomen, and stop the hæmorrhage.

The patient was carried to the operating room in her bed. I was convinced that the ligature on the cystic artery had slipped and that this was the source of the hæmorrhage. However, she was so nearly dead that it seemed to me, and to my associates, that any attempt to open her abdomen would be immediately fatal. She was given a blood transfusion of about 500 cc. Her condition improved but very little. After waiting several hours, expecting her death at any moment, we gave her another blood transfusion of 500 cc. To this transfusion she made definite, though slight, improvement. Even up to this point her condition was so precarious that we were afraid to make any formal effort at stopping the hæmorrhage. Early the next morning we could be reasonably certain, through observation of the gauze drainage and cutting of one suture next to the drain, that she had had no further bleeding.

To make a long story short, this patient was never reoperated on. At this time she is perfectly well, and we believe that her recovery was due to the fact that she was simply “waited out” and that no operative effort was made to control the bleeding from the cystic artery.

You can see the point that I am trying to make. The problem in the first instance was the simple problem of doing a conventional cholecystectomy. Faced in the second instance with immediate death from a surgical calamity, the great problem involved was one of discriminating surgical judgment, and on the correctness of this judgment hinged the matter of life and death.

This much we absolutely know—that the patient is today alive and well.

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and no secondary operation was performed for the relief of her hæmorrhage

An old axiom of medicine and surgery is to give the patient every possible chance. It is a very easy thing, in the presence of such an emergency as outlined above, to deprive the patient of her only chance.

The physician or surgeon who learns properly to evaluate the "*vis naturae medicatrix*" has attained the beginning of wisdom. There is scarcely any limit to her capacity to help.

We could continue indefinitely with similar illustrations to prove that in the handling of the acute abdomen this thing of discriminating judgment, wrought out of a background of clinical experience, is the great desideratum.

We have only time to hint at the difference of the problem involved in an unruptured appendix on the one hand and a perforated appendix with peritonitis on the other, or a simple cholecystitis as against a perforated gall-bladder with peritonitis, or a simple cyst of the thyroid as against an intensely toxic hyperplastic thyroid, or a simple duodenal ulcer as against a perforating duodenal ulcer. And so on we could furnish illustrative cases to the very end of the chapter.

After an experience of a bit better than thirty years, there is no problem in surgery about which I have altered my attitude more thoroughly than in the matter of the acute abdomen. This business of rushing into the acute abdomen with precipitate haste, simply because it is acute, is all wrong and carries with it its own label of incompetency. In many, many cases the urgent thing to do in the acute abdomen is to leave the patient to the unimpeded efforts of nature. The operator simply has before him the problem of operative interference, while the surgeon possessed of discriminating judgment will be, or should be, able to separate the cases that need prompt intervention from those whose chance for life would be conserved by reasonable delay.

The surgeon who puts aside sound judgment and precise anatomical knowledge for the age-old axiom of "cut and tie" will surely "reap the reward of his labors."

*Axioms*—May we now take a more intimate view of our subject.

(1) Don't be in too great haste to operate. Nearly always there is ample time, not only to be reasonably sure of your position, but to improve the patient's general condition. The surgeon should control the initiative and dictate the terms under which the battle is to be fought. The easiest way to make a fatal error in judgment is to be hurried.

(2) Don't delay operating unduly in the hope of making a complete diagnosis. Certainly this is true in the presence of the acute abdomen. A complete diagnosis much of the time is impossible. I do not worry too much nowadays about the question of diagnosis in the presence of a surgical abdomen. What gives me endless concern is this: Are the indications sufficiently clear for going in? There is ample time for complete diagnosis when the abdomen is opened. Understand me here, I am not belittling diag-



nosis, for it is one of our sheet anchors. We must keep a clear perspective and properly evaluate the patient's condition.

(3) Don't, please don't, continue the vicious practice of using purgatives in the presence of acute lesions of the abdominal cavity. This is a trite statement, and very much has been written about it, however, patients continue to come in day in and day out in which this fundamental point has been disregarded.

Many of our ablest surgeons contend that there is no such thing as a diffuse peritonitis following a perforated appendicitis in which purgative medicines have not been used. This may not be literally true but there is a vast amount of truth in the statement. Purgation is the very badge of ignorance so far as the acute abdomen is concerned. Purgation in the presence of an acute intraperitoneal infection may readily be fatal.

(4) Don't give morphine until the diagnosis has been made or until you are reasonably certain that operation is to be done. It will surely mask the symptoms and lull you into a false sense of security. The truth of the matter is this, morphine puts two people to sleep, the patient on the one hand and the doctor on the other. Also remember that if it takes more than one-half gram of morphine to relieve an attack of appendicitis it likely means that you are not dealing with appendicitis but probably with stones in the gall-bladder, kidney or ureter.

(5) Don't fail in the vitally important matter of proper drainage. When once decision is made for operation, particularly in the presence of intraperitoneal suppuration, we must be thorough and radical in our handling of the pathological process. Adequate drainage is one of the essential elements of success. The very popular statement of "when in doubt don't drain" may be witty after a fashion, but it is altogether vicious as a surgical principle. I am afraid of pus in the abdomen. It matters not what its origin or what the amount. If we handle intra-abdominal suppuration carelessly we will come to know the meaning of the appellation "trickster."

(6) Don't fail to grasp the difference between a contaminated wound and an infected wound. I mean precisely this. In the presence of intraperitoneal suppuration, notably in reference to appendiceal abscess where there is obliged to be gross soiling of the tissues, if the technic and intraperitoneal toilet has been correct, drainage complete and thorough, closure of the wound properly handled, one can be practically sure of primary union in 85 per cent to 90 per cent of the cases, and a suppurative appendix can be well-nigh turned into a clean case so far as morbidity and confinement to the hospital are concerned. Such a wound we think of as a contaminated wound. If, on the other hand, the same identical wound is sewed up tight, hermetically sealed as it were, the wound will break down in 90 per cent of the cases with extensive suppuration. In this instance the wound is viewed as an infected wound. It is of basic surgical importance to remember that the pus that does the damage is the pus under pressure.

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(7) Don't fail to remember that nothing so mars the convalescence of a patient or compromises more directly the result of an operation than wound infection. A simple but rigid, aseptic technic, gentleness and respect for the tissues in the manner of handling them, are matters of primary importance. The size, the extent, the location of the incision, the readiness with which the incision gives the surgeon access to and control of the field of operation, constitute the epitome of operative surgery.

Knowing what not to do is just as important as knowing what to do. This is especially true in the presence of the acute abdomen, for the surgeon is a good surgeon who knows when he is doing harm and will quit.

I close by reminding you that the father of medicine has bequeathed to us this sage axiom: "Life is short, art is long, experience fallacious, judgment difficult."

## CHOKED LEG

BY JOHN EDWARD JENNINGS, M D

OF BROOKLYN, NEW YORK

IN 1922 AND 1923, interested by the work of Leriche and his reports of it, I, with many others at about that time, attempted to apply his operation of peri-arterial sympathectomy to the treatment of various forms of threatened gangrene of the toes and feet

I have reported some of these experiences elsewhere and will allude to them here for only one purpose. Quite as much by accident as by design, at first I found it convenient to do the operation in Hunter's canal and I found that I was obtaining better results than my fellows who were operating on the artery higher up. At first we attributed this to the somewhat different technic of the arterial stripping which was measured in distance and thorough in depth, but as we went on, the anatomical findings in Hunter's canal suggested a train of thought and initiated an inquiry which has seemed of some interest.

"Hunter's canal, or the Adductor canal" [canalis adductorius Hunteri] says Gray, "is the aponeurotic space in the middle third of the thigh, extending from the apex of Scarpa's triangle to the femoral opening in the adductor mangus muscle. It is bounded externally by the vastus internus, internally by the adductors longus and magnus and is covered in by a strong aponeurosis which extends transversely from the femoral vessels to the adductor longus and magnus, lying on which aponeurosis is the sartorius muscle. It contains the femoral artery and vein enclosed in their own sheath of areolar tissue, the vein being behind and on the outer side of the artery and the internal or long saphenous nerve lying at first on the outer side and then in front of the vessels."

It has been interesting to trace the use of Hunter's name to the adductor canal in which he first tied the femoral artery for popliteal aneurism.

"The first operation of this kind ever done was performed on a coachman by Mr Hunter in St George's Hospital December, 1785. An incision was made on the anterior and inner part of the thigh, rather below its middle, which wound was continued obliquely across the inner edge of the sartorius muscle and made longer in order to facilitate doing whatever might be necessary. The fascia covering the artery was then laid bare for about three inches, after which the vessel itself could be felt. A cut about an inch long was then made through the fascia along the side of the artery and the fascia dissected off. Thus the vessels were exposed, *etc*, *etc*."

It is evident that this ligation was done in the adductor canal which is not here so discussed nor is the name of the great surgeon mentioned—anatomically. Scarpa later advised tying the artery higher up above the canal and his opinion has prevailed.

Then Hunter and his immediate contemporaries did not refer to the adductor canal in his name and the first reference I have been able to find is in "Holmes' System of Surgery," 1860.

## CHOKED LEG

One suspects the teachers of operative surgery on the cadaver rather than the anatomists of this, at any rate it is well settled in British anatomical literature now. It defines a well-recognized space and its repetition serves to remind us of a noble name in surgery. Let it remain.

As we continued to perform sympathectomy on the femoral artery in the canal of Hunter we noted in some cases that the space about the vessels was filled with loose areolar tissues from which the artery was easily separated but that in others this bed was frozen by old inflammation and that it required time and effort to free the vessels which was not always accomplished without damage to small branches of the artery or to branches of the closely adjacent vein and in a few cases we found an increased tension within the canal which was quite evidently relieved when its roof was laid open. It seemed that the canal was the site of a perivascular lymphangitis usually in this group of cases of long standing and we wondered what, if any, relation this may have had to an arterial spasm at or below this point.

This led to the suspicion of the possibly important place that this area holds in the distribution of the blood and lymph circulation of the leg. It seems evident that the arterial blood supplying the leg, save for the normally insignificant anastomotic circulation around the knee, passes through this canal. The same is true of the deep venous return and also of the deep lymphatic vessels.

A middle-aged man, who had suffered from osteomyelitis of the right femur for many years, had been operated on a number of times and had always had several discharging sinuses, found the characteristic swelling and brawny œdema of his leg growing more and more painful and disabling. Then two ulcers appeared on either side of the lower third of the leg. These ulcers healed or nearly healed when he was confined to bed but immediately reopened when he resumed activity. He finally asked for amputation and this was done through the upper third of the thigh. Hunter's canal, with its contents and the surrounding muscles was excised from the amputated limb and studied. The perivascular lymph bearing areolar tissue was found œdematous, indurated, the seat of round-cell infiltration densely packing the canal and evidently compressing the artery and vein and blocking the lymph channels in it. This block must, it would seem, have varied with posture and with greater or less venous pressure. Perhaps to some extent with the rise and fall of pressure on the artery and not improbably with intermittent inflammation and congestion in the lymph structures around the vessels.

This led to the question in our minds—is it possible that cases of phlebitis of the femoral vein, with the attendant swelling of the leg, may depend for their early exhibition of this sign upon a lymph block in this space, and might an old case, with continued swelling of the leg and pain on standing or walking, be benefited by opening widely the roof of the canal with relief of tension?

An opportunity to test this matter soon presented itself. W. S., thirty-nine, a clergy-

man, gave the following history. He had appendicitis followed by pneumonia and later by phlebitis of the right leg in 1917. He was ill for six months after which he recovered and had been able to perform his duties, but his leg had always been swollen, had always ached on moderate exertion and if he attempted to use it long the pain became very severe. He had been somewhat benefited by the use of an elastic stocking. Eighteen months ago a small, irritable ulcer formed just above the malleolus and had been open a good deal of the time since. It is now about one centimetre in diameter, surrounded by an area of brownish induration six centimetres in width. There are no superficial varices evident. The leg is 3 inches larger than its fellow at the calf. Is not tender, does not pit on pressure. The other leg is normal and all other findings are negative. *Operation.* An incision eight inches long along the lower third of the inner surface of the right thigh following the course of the sartorius muscle was made. The sartorius sheath was opened, the muscle retracted and Hunter's canal freely opened from end to end. The vessels were tightly constricted at the lower third of the canal, the vein was almost entirely obliterated in the canal, dilated above and varicose below. The vessels were freed from the constricting roof of the canal after which they expanded. The ulcer was undermined through a small slit an inch above it. The skin incision was closed with interrupted sutures of silkworm gut. Convalescence was uneventful. His ulcer healed while he was in bed. His pain, to his surprise, did not return when he began to walk and he reports, a year after his operation, that he is completely well, able to stand all day with no ache or swelling of the leg, which is one inch larger than the other.

Encouraged by this experience, a second presented itself. Mrs. V., forty, white, widow, four children. July 9, 1932. About four years ago an acute attack of abdominal pain which was considered salpingitis. At this time she had a double phlebitis which never completely subsided. This has gradually been getting worse, especially on the left side, so that she is now completely incapacitated. Both legs are swollen even after rest in bed for two weeks. The left leg measured  $19\frac{1}{2}$  inches, the right 15 inches. The left extremity was somewhat tender along the course of the femoral vessels. There was some tenderness in the right fornix. The cervix showed an old laceration. The uterus was in normal position and of normal size. *Operation.* An incision along the inner lower third of the left thigh following the medial border of the sartorius was made. The muscle sheath was opened and the roof of Hunter's canal exposed. The femoral artery was exposed and lifted from dense inflammatory tissue which surrounded it, wounding the almost obliterated vein and artery. The bleeding was controlled by fine silk sutures. The canal was opened widely from the popliteal space to its upper limit and the fascia, and skin closed. Her convalescence was uneventful. She went home much improved but this was of short duration and she returned to the hospital for observation. Her leg became much smaller (from  $17\frac{1}{2}$  to 14 inches in circumference) while in bed. Pain continued but was not so severe. Pelvic examination showed tenderness in both fornices more marked on the right. No masses. Uterus somewhat large and in first-degree retroversion. We decided to explore the pelvis and if possible to do a left lumbar ganglionectomy. This was done with difficulty and distress. The pelvis was found free and clean but there was great dilatation of the right pampiniform plexus. Obliteration of the external iliac vein diminished the lumen of the common iliac. Incision too low for good exposure, increased in length. Vein entering cava deep behind the aorta impaired in dissecting sympathetic. Clamped. Trouble in tying, free bleeding, four clamps applied, two Keith's and two Kochers left in. Apparently a branch of the azygos dilated to compensate for the obliteration of the iliac. Her post-operative course was painful. The clamps were loosened on the fourth day and removed one at a time on the three succeeding days, after which her pain which had been diffuse over the left thigh and buttocks, with marked hyperæsthesia, subsided slowly. In about three weeks after her operation she was able to walk without pain and went home. She returned in a month steadily improving and with less than an inch of swelling of the leg after walking about the house. Her pain was almost gone.

## CHOKED LEG

A month after this, however, she returned with increased pain which came on when she walked a block and became so severe that two blocks was all she could manage. She would then rest and allow her pain to subside when she could again walk two blocks more. She complained of pain in her leg, reflected down from a spot below and to the outer side of the knee and of sharp shooting pain radiating from a point in the lower end of the scar on the upper and inner side of the thigh.

She remained in the hospital for six weeks when she went home again improved but she still complained of pain on any prolonged exertion, being able to walk about two blocks at a time when she has to sit down and rest. The leg is swollen on exertion but not so much as before. The pain is different but still quite severe at times. It was decided to re-explore the femoral vein and artery. The scar on the left thigh, six inches long, was removed and dissection carried down to the femoral vessels. The artery was found stenosed, practically obliterated at the site of previous injury. The artery was cut between ligatures. The vein lying behind it was thickened, adherent and contained little blood and about a third of its normal lumen. One and a half inches of the vein was removed between ligatures and the muscle and skin closed. Following this third operation her improvement has been steady with two interruptions in which pain and tenderness have arisen along the lower part of the femoral and popliteal veins, apparent extensions of a localized phlebitis. In another similar case, I should excise the femoral over a much larger area.

The case is, however, very suggestive and I think indicates the further exploration in Hunter's canal of obstinate cases of femoral phlebitis. Sections of the vein removed showed thrombosis with organization and recanalization of the vessels and marked perineural fibrosis.

A study of the literature finds little save several articles by Rene Leriche, which, however, deserve somewhat extensive abstract. He says phlebitis of the lower extremity is common but there is little light on the late sequelæ. How many cases recover completely? What trouble remains in the mild cases which are so frequent as a post-operative complication? It is also true that we do not know what is the pathological anatomy of the syndrome we call phlebitis. An operative case, twelve days or so after, has a pain in the calf. Soon he complains of pain in Scarpa's triangle and along the vein œdema appears. The limb is immobilized. In a few days he is well. After he gets on his feet he will notice for some time a little œdema in the evening, then all is over. What happened? Was there really an inflammation of the vein wall and an obliterating thrombosis? If there was a thrombosis where was the clot? How extensive was it? Did it become organized? What is the mechanism of the œdema in these cases and does it disappear so quickly? Frankly we know nothing of all this and yet these cases are so common that we ought to know more.

He describes a group of cases of chronic œdema of the lower extremity in middle-aged patients. The œdema is rather hard, very different, however, from the œdema of elephantiasis, often painful, deep red at rest, cyanotic in the erect posture, occasionally small ulcerations on the leg. He tried, in a few cases, peri-arterial sympathectomy in Scarpa's triangle without avail.

In another group of cases he found external iliac obliteration partial or complete due to old pelvic inflammation and describes operations freeing the constricted iliac veins. His cases were promptly benefited by the abdominal surgery but recurred. In one case of obliterated iliac vein on which lay an inflamed ovary, he resected the obliterated vein from the bifurcation to the femoral ring performing also a peri-arterial sympathectomy with complete recovery. He says the œdema was evidently removed by the resection of the vein and not by the removal of the ovary nor by the sympathectomy. Resection of an obliterated external iliac vein has no effect on the hydraulics of the leg. It must then have acted in suppressing a permanent cause of vascular reflexes causation of œdema.

Masson examined tissue removed (iliac vein) and found no trace of lymphatics but in a mass of connective tissue a large number of sympathetic fibrils and ganglion cells.

He even reported the existence of a sort of para-ganglion found by interlacing sympathetic fibrils away which were tactile corpuscles and groups of large cells with vacuolated protoplasm and fine granules with the appearance of chromofine substance. He draws two conclusions—the lymphatics are not to blame. The sympathetic elements are certainly affected by the process of sclerosis and one may conclude, sympathetic irritation is probably a contributing cause of the œdema.

He continues in the major phlebitis of the femoral vein which changes the vein into a fibrous cord, the later appearance of varices betrays the absence of permeability of the principal drainage route but when no venous trouble persists it would seem that the phlebitis has remained localized. The pain at its beginning may be due to spasm like that which follows the injection of a caustic. This may explain the occasional efficacy of leeches, *etc*. This constriction may be the cause of the œdema obstructing venous return. Anyway, when the spasm relents, as soon as circulatory equilibrium is re-established, the œdema disappears and the patient is exactly in the condition of one who has, at one point of his femoral vein, a well-tolerated ligature. However, after some time some of these patients complain of great fatigability or pain of distressing cramps and of a little œdema. What can be done for them in an operative way?

In two cases he discovered a femoral vein from Scarpa's triangle to Hunter's canal. It was found small, flattened, hardly filled with a much reduced circulation. He concluded that there was somewhere lower down a complete obliteration and that the vein now only functioned as a secondary collateral. Not finding the obstruction he tied the vein, removed a specimen and did a femoral sympathectomy.

In another case he says he should have carried his exploration to the popliteal space if time had permitted and may have to for complete relief. In this case he merely freed the vein.

In a series of cases in which Hunter's canal was exposed for peri-arterial sympathectomy perivascular changes were found grossly indicative of long-standing chronic inflammation.

In two cases of painful œdema following femoral phlebitis, a condition for which choked leg seems a convenient term, the vein was explored in Hunter's canal and thickening of its walls with partial obliteration and varicosity were found. In one of these cases freeing the roof of the canal and liberation of the vein brought prompt and lasting—one year—relief. The other was followed by temporary relief after which an abdominal sympathectomy was done with slight improvement after which re-exploration of Hunter's canal was done and the vein tied and cut but not resected. This has been followed by period of complete relief and by two periods of localized pain and tenderness over the lower portion of the femoral vein. The swelling has been reduced from nineteen inches to fifteen inches and is stationary.

It is suggested that in cases of chronic œdema of the leg following phlebitis, Hunter's canal be widely opened and explored and that if the vein be found extensively thickened or varicose or both, that it be resected for its entire length.

The pathological anatomy of these two cases seems clear. A partially obliterated, chronically inflamed and varicose vein, the site of intermittent back pressure in the closed space of the canal of Hunter. In one case the release of this closed space was adequate, in the other it was not, nor was ligation and section of the vein entirely efficient.

## PRE-OPERATIVE IRRADIATION IN CASES OF CANCER OF THE BREAST WITH AND WITHOUT BIOPSY

BY JOSEPH COLT BLOODGOOD, M D

OF BALTIMORE, MD

THIS is the second paper devoted to this subject which I have presented before the American Surgical Association

I am discussing the value of a course of irradiation with X-rays or radium in cases of clinically malignant tumors which are operable. Further experience since my paper published one year ago and a recent restudy of the entire group of cases of malignant disease subjected to treatment by X-rays or radium convinces me that in every local lesion which presents itself with a clinical picture suggesting the possibility of malignancy and for which in the past and even today surgery has been selected as the treatment of choice, to be followed by irradiation, there should be a consultation between the surgeon and a radiotherapist as to the question of pre-operative irradiation. At the present time this rarely occurs. In the majority of clinics the patient enters the surgical department, the operation is performed, the pathology established, and then post-operative irradiation is considered. This method of treatment has become almost universal after operations for cancer of the breast. In my last paper I called attention to the remarkable results of Mr. Keynes, surgeon to St. Bartholomew's Hospital in London. There has been no publication since his article in the British Surgical Journal in February, 1932. In my previous paper I mentioned my visit to his clinic, and the good impression made upon me by seeing with Mr. Keynes his remarkable results. During the past year, with the rarest exceptions, my cases of cancer of the breast have been subjected to a thorough course of treatment with radium or X-ray before operation. It is impossible as yet to make any statement as to results. I have been unable, in this group, as yet to distinguish any microscopical changes in the tumor tissue and in every instance in which cultures were taken the cancer-cells have grown. This experiment has been carried on with the aid of my colleague, Doctor Burnam, but the experiments are by no means concluded. The character of cancers of the breast coming to my clinic has changed tremendously. In the first place, there is a very large increase in the number of lumps of the breast of very short duration, but which are clinically malignant as based upon slight retraction of the nipple and slight fixation of the skin, and in this group, the glands as a rule are not involved. These patients have at least a 70 per cent chance of a five-year cure. All I know is that a lethal dose (so-called) of radium given by Doctor Burnam twenty-four to forty-eight hours before the operation produces no change in the cancer-cells when studied micro-



scopically, and these cancer-cells grew when cultivated by Doctor and Mrs Gey

I have no evidence that the delay caused by pre-operative irradiation in these very early cases of cancer of the breast is harmful

This group of malignant tumors of the breast, clinically in the early stages, which have received pre-operative irradiation is very small, and the intervals of time between the irradiation and the operation a matter of a few days. In the discussion, my colleague Doctor Burnham will record the details of his technic and dosage

In the second group, the cancer of the breast has been more advanced clinically, even up to ulceration of the skin and palpation of the axillary glands. The pre-operative irradiation has been carried on longer, but so far we have been unable to distinguish with the microscope any changes or failure of the cancer-cell to grow. When I say longer, I refer to those cases in which the irradiation was carried for the same period, but the operation was delayed from ten days to two weeks. In my own cases, we have not given post-operative irradiation unless the glands in the axilla were involved. Therefore I will be unable to compare the results of pre- and post-operative irradiation. For some ten years my associate Doctor Kahn and other radiologists throughout the country have given thorough and often repeated post-operative irradiations in cases in which the glands in the axilla have been involved, and I have again and again in recent literature made the statement that I have been unable to find any evidence that post-operative irradiation with X-rays and, in some cases, with radium, has had any effect on the five-year cures. This has been confirmed by the recent work of Williams, of St Thomas' Hospital, in London.

I take the liberty to state that the operative results of cancer of the breast observed by me are based upon a very large number of operations performed by Halsted himself and by his associates who were taught by Halsted. Mr Schapiro estimated for Doctor Halsted his first statistics and the figures obtained by him have remained practically unchanged since the first report. They are as follows: Glands not involved, 70 per cent five-year cures, base glands involved, 25 per cent cures, mid glands involved, 20 per cent, apex glands involved, 10 per cent, supraclavicular glands involved, 4 per cent. These last figures, we now know, are of no particular value, because 4 per cent of all cancers of the breast, even with the recurrences and skin metastasis to bone, may live in relative comfort for five years. It is in this group that I was unable to determine any improvement in the number of five-year cures after the very best post-operative irradiation. It is essential to know that in every clinic cases of cancer of the breast without glandular involvement or with low glandular involvement, are on the increase. Therefore, even when the surgery is not as efficient as that of Halsted and his specially trained associates post- or pre-operative irradiation might show apparent improvement which could be explained more readily by the absence of glandular involvement. It will be five years, perhaps, before I will be able to determine the value of pre-operative irradiation in the group with glandular involvement.

## PRE-OPERATIVE IRRADIATION IN CANCER

Let me state here that in very few clinics is there any positive record of the exact involvement of glands—base, mid or apex

I propose, therefore, to continue with pre-operative irradiation in operable cases of cancer of the breast. The number of cases so treated is on the increase

We have one remarkable observation which I could not record in my first paper, but will be recorded here. This patient had an apparently inoperable cancer of the right breast, due to the tremendous involvement of the breast, although the axillary glands were not palpable. X-ray pictures failed to disclose any metastasis. The patient, although only sixty-five years of age, was feeble and not a good operative risk for a huge dissection of the chest-wall. In this instance irradiation was administered by Dr. Howard A. Kelly and his son. The irradiation was very extensive with the four-gram pack in addition to interstitial irradiation with radon seeds. Nothing else was done for three months. The patient was not at all disturbed by the irradiations. At this time there was such an improvement in the local growth that, after consultation with Doctors Kelly and Burnam, I performed, under avertine anaesthesia, with the electric cautery a complete chest-wall excision of the breast, large area of skin and the lower portion of the pectoral major muscle. No evidence of cancer was found in the periphery of the tissues removed, and, as I could feel no glands in the axilla, no axillary dissection was made, chiefly because the patient was a bad operative risk. This patient had serious post-operative complications—bronchopneumonia, acidosis, mental symptoms suggesting metastasis to the brain, from all of which she made a recovery. Later the granulating wound was grafted. Today, more than one year after operation, there is not a sign of recurrence, and the patient, although still feeble, is well. The microscopical and cultural results were in contrast to these in the previous group. The amount of irradiation given at any one spot was perhaps greater in the first group mentioned. In the first place, the cells failed to grow in tissue culture, although a duplicate piece of that taken for culture showed under the microscope apparently morphologically viable cells. That is, these cells had the same staining characteristics as those in the first group in which they did grow in culture were similar to those and in previous cases in which there had been no irradiation. In this breast which had had this extensive irradiation three months before operation there were found, in many sections, three types of tissue—one, a distinctly new type of connective tissue different from that in the normal breast, in which we could find no remaining parenchyma of the breast and no evidence whatever of cancer-cells, stained or unstained. In a second area we have the same connective tissue with perfectly evident outlines of cancer-cells in which nothing stained but the faint outlines. In a third field were nests of typical cancer-cells which could not be differentiated from those in a cancer of the breast that had not been exposed to irradiation. This is the first time we have been able to prove from the standpoint of cell culture the death of the cancer-cell after irradiation. I am convinced that we have much to learn about pre-operative irradiation in distinctly operable cancer of the breast, and I am

inclined to feel that more time should be devoted to the pre-operative treatment, especially when the glands are palpable and we know that the chances of a five-year cure after surgical treatment alone are only 20 per cent. When the tumor is an early one, small, and the clinical signs of malignancy very recent, and when the glands are not palpable, I think it might be wiser as yet to use the method of irradiation followed by Doctor Burnam.

It should be recorded here that inability to palpate the glands in the axilla does not exclude their involvement, even very extensive involvement.

There is a new group which is constantly increasing and that is the group of clinically benign tumors of the breast which transilluminate dark and should be explored, and the clinically benign tumors of the breast—much smaller than a twenty-five-cent piece, which, even when they do transilluminate light, should also be explored. The indications for exploration lie in the possibility of malignant disease, and to reach a decision from the microscopical study as to what should be done.

In clinics where there is a properly trained pathologist who can recognize cancer and differentiate it from border-line tumors, it seems best to follow this rule with, perhaps, two exceptions. If the frozen section made at the time of the operation shows distinct malignancy, but not a Broder's Group IV, acute carcinoma, and not a distinct pure comedo-duct cancer, the complete operation should follow at once. However, if the sections show a Group IV acute carcinoma or a comedo-duct acute cancer, the tumor should be excised with the cautery, the wound closed and the patient treated as quickly as possible with irradiation.

Two years ago I explored a clinically benign lump of short duration in the upper hemisphere of the left breast. It transilluminated dark and felt like an adenoma. The frozen section showed a Group IV acute carcinoma. The patient was about forty years of age, the glands were not palpable. I immediately performed a very extensive operation with the cautery. The glands showed no evidence of metastasis. In spite of this I gave post-operative irradiation. There was almost immediate skin metastasis, recurrence, and later cancer encircled. I feel confident that the patient would have lived in greater comfort if only the tumor had been removed, the wound left open and irradiated. Dr. Max Cutler, who is present during this dictation, asks "Why leave the wound open?" The probabilities are that it would make no difference in the ultimate result, but such a tumor should be not only cut out with the cautery, but the wound itself cauterized. These wounds left open to heal by granulation give less trouble and heal ultimately just as well as when they are closed and break down secondarily due to either a hematoma or serous exudate from the burnt tissue, or due to the effects of the immediate irradiation. This is a minor point, however, compared with attempting the complete operation after the excision of a small tumor when the frozen section reveals an acute carcinoma of the Group IV type. These patients with recurrence after the complete operation suffer much more and do not get palliative relief equal to those who come under observa-

tion with the clinical picture of acute carcinoma—operable or inoperable—who receive irradiation but no operation

Cases similar to this one are on the increase and will continue to increase, because when women delay one month or longer after feeling a lump in the breast, the acute carcinoma rapidly assumes the definite clinical picture of malignancy, then of inoperability and then of cancer en cuirasse. In previous years, every case of cancer en cuirasse was inoperable. Today I frequently see operable cancers en cuirasse. None of them as yet has been cured by the most extensive surgery with post-operative irradiation, nor as yet by pre-operative irradiation. The patients with cancer en cuirasse made most comfortable are those who have received irradiation only—none have been cured.

Now, in regard to the comedo or duct cancer. I saw this first in 1893, forty years ago. Doctor Halsted explored a clinically benign tumor about the size of a five-cent piece, it was not encapsulated, it cupped on section, yet it was not gritty like typical cancer. Its characteristic fresh appearance was when pressed upon, worm-like, or comedo-like, masses of granular material were expressed. Under the microscope, there were large alveoli containing cells of the Grade I type, some with and some without a central cavity from which necrotic cells have been lost during the hardening and sectioning process. I have been studying this group of duct cancer all these years. This case established the rule. There was nothing in the microscopical section but this typical characteristic histological picture, as typical as colloid cancer. There were no cancer-cells outside these areas, the glands were not involved. The patient lived thirty years and died of other causes. The only cases diagnosed cancer and operated on before 1900 which lived twenty-five or more years were duct cancers of this type which I described as comedo-adenocarcinoma without involvement of the glands. Further evidence of the low grade of malignancy was furnished by a colored woman whose breast was occupied by a fungous tumor, fully the size of a soup plate. A most extensive chest-wall dissection was performed with the removal of the axillary glands. The glands were not involved, the muscle was not infiltrated, every section taken from this huge fungous tumor showed the typical picture of pure comedo, and there was no infiltration of these cells outside the duct. The patient died five years later of cancer of the cervix with no evidence even of local or general recurrence of the breast lesion. There was another more convincing evidence of the benignancy or low grade of malignancy, of the pure type of comedo adenoma or adeno-carcinoma. There is a photograph by Dr. Harvey Cushing, taken in 1898, of a small fungous tumor occupying the scar on the chest-wall after the removal of the breast for some type of breast tumor. Again, the most radical dissection was done, the glands were not involved, the microscopical picture of the fungous tumor was identical with that in the previous case. This patient lived without recurrence ten or fifteen years. Halsted reported these two cancer cases in his paper on adeno-carcinoma. This type of tumor, which is about as uncommon as colloid cancer, may come under observation as a small, clinically benign tumor, or a diffuse involvement of the entire breast not unlike Schim-

melbusch's disease, except that it has always been unilateral. The entire breast may be involved, with the identical histological picture, without involvement of the glands, and the same ultimate cure. One case representing one per cent of the total number of five-year cases, in which the glands were not involved, died with symptoms of internal metastasis, but clinically a primary abdominal lesion could not be excluded. During this period we have observed about an equal number of scirrhus and medullary carcinomas with microscopical areas of this duct or comedo type. The prognosis in this group is identical with that of medullary or scirrhus carcinoma—70 per cent of five-year cures when the glands are not involved instead of 95 per cent, and 25, 20, and 10 per cent, according to the extent of glandular involvement.

After this experience, I decided that if I encountered at an exploratory incision a pure duct or comedo adenoma or adeno-carcinoma, I would remove the tumor with the cautery and subject the patient to immediate irradiation, and do nothing more. This happened about six months ago. The tumor was the size of a ten-cent piece in the periphery of the upper hemisphere of the breast. It transilluminated dark like an adenoma. It did not have, however, the distinct encapsulation of an adenoma. Under local anæsthesia I excised the tumor with a good margin of breast tissue. In the gross it was a non-encapsulated area suggestive of malignancy, but it did not feel gritty on cutting like a carcinoma, nor could we express worm-like or comedo masses. The frozen section was diagnosed duct or comedo cancer. The patient was sent at once by automobile to Doctor Kelly's Hospital and given radium treatment over the wound and the axilla. She left for home in her automobile the same day. The wound broke down either from a hæmatoma or irradiation, or both. Remember, the tumor had been excised with the cautery with a good margin of fat and breast tissue. A full course of irradiation was given. The wound now has healed, and there are no palpable glands.

These two cases represent new departures in treatment which I have had under careful consideration for years, especially the duct cancer. I was not prepared, when I explored the acute carcinoma, to restrict the operation to the removal of the tumor only and to depend upon irradiation, not so much for a cure as for prevention of suffering during the short time the patient had to live. We have no evidence that an undoubtful grade IV acute carcinoma of the breast, even without glandular involvement, is ever cured by the most radical surgery, just as we have no evidence that the earliest stage of cancer en cuirasse, operable and without glandular involvement, is ever cured by pre-operative and post-operative irradiation. Nor have we any evidence that a fully developed Paget cancer of the nipple with extensive involvement of the nipple and glands is ever cured by irradiation. When Paget's cancer of the breast is confined to the nipple the prognosis for surgery alone is identical with that for scirrhus cancer of the breast. Perhaps the most difficult problem to solve is when a clinically benign tumor of the breast in a woman at the cancer age is removed and the pathologist examining the frozen section is doubtful as to its malignance. What shall he tell the surgeon to do, or what shall the surgeon decide to do? Formerly, my advice was to give

the patient the benefit of the doubt and do the complete operation for cancer. Today that advice is reversed. It is: Close the wound and, if deep X-ray therapy or a radiotherapist with sufficient amount of radium is available give irradiation over the wound and over the axilla. On the theory of probabilities, the chances are that when this section is submitted to a number of pathologists they will either diagnose it benign or doubtful, a few may call it malignant. If the diagnosis of all the pathologists is malignant, finish the course of irradiation and then, if the diagnosis is not acute carcinoma of Grade IV type and not a duct adenoma or adeno-carcinoma, perform the complete operation for cancer. This new point of view about cancer of the breast furnished the best evidence of the new attitude in regard to the treatment of cancer—cancer is no longer a purely surgical disease in which the diagnosis is made clinically and an operation performed. The management of cancer depends upon the cooperative teamwork of an ultra-trained pathologist, radiotherapist and a surgeon who still has the training, the conception and the execution of the great pioneers in complete surgery for cancer—Billroth, Kraske, Halsted, Wertheim. When we receive in the laboratory a specimen of a lump removed from the breast, and the section shows undoubted cancer, we advise at once by telegraph a course of irradiation and later the complete operation. It is encouraging to state that this is happening less frequently every month. Most of the tumors of the breast sent to us for diagnosis have been clinically benign, the operator has concluded from the clinical appearance that they are not cancer, and the pathologist has been uncertain. My first experience, beginning more than thirty-five years ago, was the reverse—the tumors of the breast sent to the laboratory for diagnosis were in the gross appearance and microscopically cancer, and we found that in spite of the complete operation with as a rule not more than two weeks delay, the ultimate cures, whether the glands were involved or not, were distinctly less than in the same type of tumor with and without involvement of the glands which were subjected to the immediate complete operation without preliminary excision of the tumor and a delay of two or more weeks.

These remarks in regard to the breast are preliminary. A complete paper will soon follow with greater detail and a little longer interval of time after the treatment of the earlier cases. I have every confidence that this new attitude will not diminish the number of five-year cures, will prevent the unnecessary removal of many breasts, and will add tremendously to the comfort of the individuals suffering with very malignant tumors of the breast. I have given the evidence which has accumulated since I wrote the paper entitled "When Should Irradiation with Radium or X-rays Precede Operation or Be Employed without Operation?" This was written in August of 1932 and published in the *ANNALS OF SURGERY* in November, 1932.

I propose later to give the accumulated evidence which favors irradiation of a cancer of the cervix without preliminary cauterization of the cervix and without hysterectomy after the irradiation. Doctor Burnam, Doctor Cutler and other authorities see no danger in the removal of a small piece with the endotherm loop for biopsy, but they see no advantage in cauterizing the

cervix as is done for erosion preliminary to irradiation for cancer Doctor Burnam tells me that their final results show that hysterectomy after irradiation yields 15 per cent fewer cures than irradiation alone, and this is estimated from tumors of the same grade of malignancy, clinically and histologically, and Doctor Cutler agrees with this

Repeated studies by myself of a very large material in the surgical pathological laboratory demonstrate that all types mass of recurrent cancers of the skin and oral cavity, even the smallest basal-cell cancers, should be subjected to irradiation first All tumors of the soft parts recurring after operation should be irradiated first All bone tumors in which the X-ray suggests malignancy should be irradiated before biopsy and biopsy should be postponed if there is improvement after irradiation The evidence favors the conclusion that irradiation has its protective value if given before biopsy

I am often asked, When shall we perform biopsy? No surgeon should perform biopsy if he expects to subject that case to the advice of a pathologist or radiotherapist upon finding evidence of malignancy or when his pathologist diagnoses malignancy In terms of golf, none should perform biopsy unless he feels prepared to carry through no matter what is found If they are not prepared to "carry through" they should call up the selected consultant and ask him about biopsy, because, in some cases, biopsy should be preceded by irradiation In all cases the method and procedure of biopsy should vary with the localization of the lesion and its extent and duration, its previous treatment In many instances the lesion is so small that complete excision rather than biopsy should be the method of choice But even in such cases pre-operative irradiation may add to the probability of a cure with the least mutilation

In conclusion, we must always bear in mind that pre-operative irradiation may accomplish an immediate and permanent cure even at the risk of a loss of an accurate diagnosis I have no evidence that properly performed irradiation, when patients are under the supervision of a trained surgeon, pathologist and radiotherapist, ever detracts from the chances of a cure Pre-operative irradiation also has its diagnostic value, and may elicit important information upon the radiosensitivity and degree of malignancy of the tumor The greatest danger of pre-operative irradiation is persisting in it too long a time The fear that pre-operative irradiation interferes with the healing of the wound is exaggerated, and the alleged danger of accelerating the growth of the tumor by irradiation with the doses at present employed is entirely unfounded

Dr Max Cutler has been present during the dictation of this paper and agrees with me in this final statement—there have been tremendous changes in the technic of both radium and X-rays with evidence of great improvement in the results, and this is associated with less danger to the blood count Rarely do we have to perform blood transfusion In addition, radium sickness has been greatly minimized Every radiotherapist should familiarize himself with these new improvements

# THE ON-END OR VERTICAL MATTRESS SUTURE

BY JOHN STAIGE DAVIS, M D

OF BALTIMORE, MD

THE suture which I have found most useful in plastic surgery where fine and very accurate approximation is desired in the skin or mucous membrane is what may be called the "on-end or vertical mattress suture" Last year a visitor watching me operate said, "I see you are using the new Sarnoff<sup>11</sup> skin stitch! How do you like it?" I did not quite understand what he meant as I was closing the skin with a stitch which I had been using for many years and which I knew others had been using This remark and the fact that the question is frequently asked as to who was the originator of the on-end or vertical mattress suture and who first described it have induced me to look into the matter While it seems of little real importance one way or the other who devised the interrupted and the continuous on-end mattress sutures, I feel that to those who contrived these most useful sutures should be given credit for priority especially as the methods are frequently being rediscovered

My interest in the on-end or vertical mattress suture is solely because I have been using it constantly with the greatest satisfaction since I first saw the interrupted type described in 1909, and the continuous type in 1917 I have searched through the literature on different types of sutures and have not found descriptions of either the interrupted or continuous on-end mattress suture earlier than those to whom credit will be given in this communication

As one acquires more experience in surgery and becomes more familiar with the literature, one hesitates more and more to claim anything as new In this connection a quotation from Doctor White's<sup>17</sup> article on "Closing the Skin in Abdominal Incisions" is pertinent He says in regard to the continuous vertical mattress suture "We have not seen this suture described or used elsewhere nor has any effort been made to trace the origin, but we are willing to believe that it was in daily use by Hippocrates" This, it seems to me, is exactly the attitude which should be taken when describing any surgical procedure which an author may think is new, because if it is new no harm is done and if it is not, then some embarrassment may be saved, when the original description, which may have been written many years before, is brought forward

It can easily be seen when reading the original descriptions of the sutures included in this report that the various authors<sup>4 8 12 13, 19, 20</sup> have devised these sutures without being aware that, in some instances, the same suture had been previously described

There are two types of on-end or vertical mattress sutures the *single, or interrupted* and the *continuous*, and we will consider them separately



*The Single or Interrupted Type*—As far as I can ascertain, the first to describe and illustrate the single or interrupted on-end mattress suture was Doctor R M McMillen,<sup>9</sup> of Wheeling, W Va, in 1909 (Fig 1) Doctor McMillen has recently sent me copies of letters from Dr Maurice Richardson of Boston, Dr John B Deaver of Philadelphia, Dr E C Dudley of Chicago and Dr F W Huntington of San Francisco, to whom he sent in 1909 a description and drawings of his suture, and all of them speak of it as a suture new to them, in replies written in July, 1909 Coming from prominent surgeons in widely scattered medical centres, it seems reasonable to believe that one of them, at least, might have been familiar with this stitch had it been previously described and used

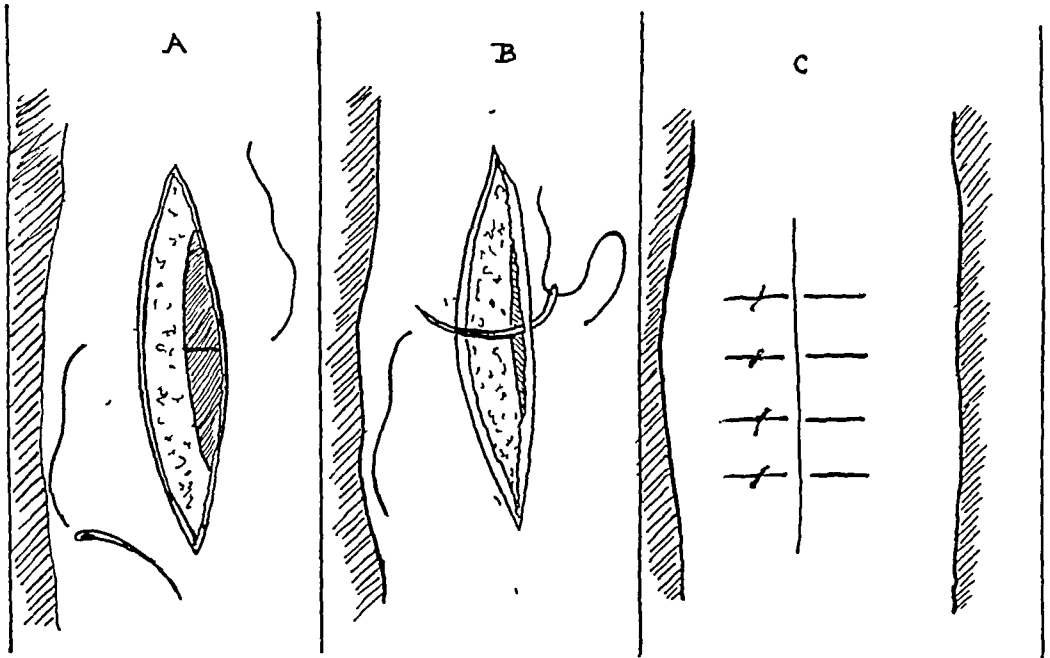


FIG 1—The on end or vertical mattress suture (Redrawn from McMillen 1909) (A) The first or deep part of the stitch is introduced in the same manner as any interrupted suture. (B) The reverse end of the suture is threaded on the needle, or the needle is reversed, and passed through the skin very close to the margin. (C) The sutures are drawn tight enough to bring the deeper portions of the wound together and are tied. The cut surfaces will be in exact apposition and the wound edges slightly everted.

Doctor McMillen's description of the suture is as follows "First put in the suture the same as the ordinary interrupted suture. Then thread the reverse end of the suture and insert the needle into the skin very close to the edge of the wound, about one-sixteenth of an inch. Pass the needle through the skin only, and on over and catch the skin on the wound side, and come out on the cuticle side about one-sixteenth inch from the edge. (Doctor McMillen has now modified this technic by reversing the needle instead of rethreading the reverse end of the suture.) The suture is then tied by a reef knot drawn with sufficient force to bring the deep structures together. The inner margins of the skin will then be seen to be in exact apposition, and the cut surfaces of the skin will be together when the pressure of the dressing is applied. The knots are at the side of the wound and their removal will not disturb the line of union. The line of union is not constricted by the suture and the blood and nerve supply is not interfered with. This suture reduces the size of the scar to a minimum."

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When using the interrupted on-end mattress suture in closing the skin and subcutaneous tissue, I have found it advantageous where there has been loss of tissue to take a few interrupted sutures, either of fine waxed silk or "o" catgut in the subcutaneous tissues to relax the tension, but these subcutaneous sutures are not necessary where there has been no loss of tissue. The knots of these sutures are tied underneath. The skin suture, preferably of horsehair and sometimes of waxed silk is threaded on two needles, one for the deep portion and the other for the superficial part of the stitch\*. With the two needles, it is easier and quicker to pass the deep and superficial portions of the suture in the same direction, than it is to use one needle and

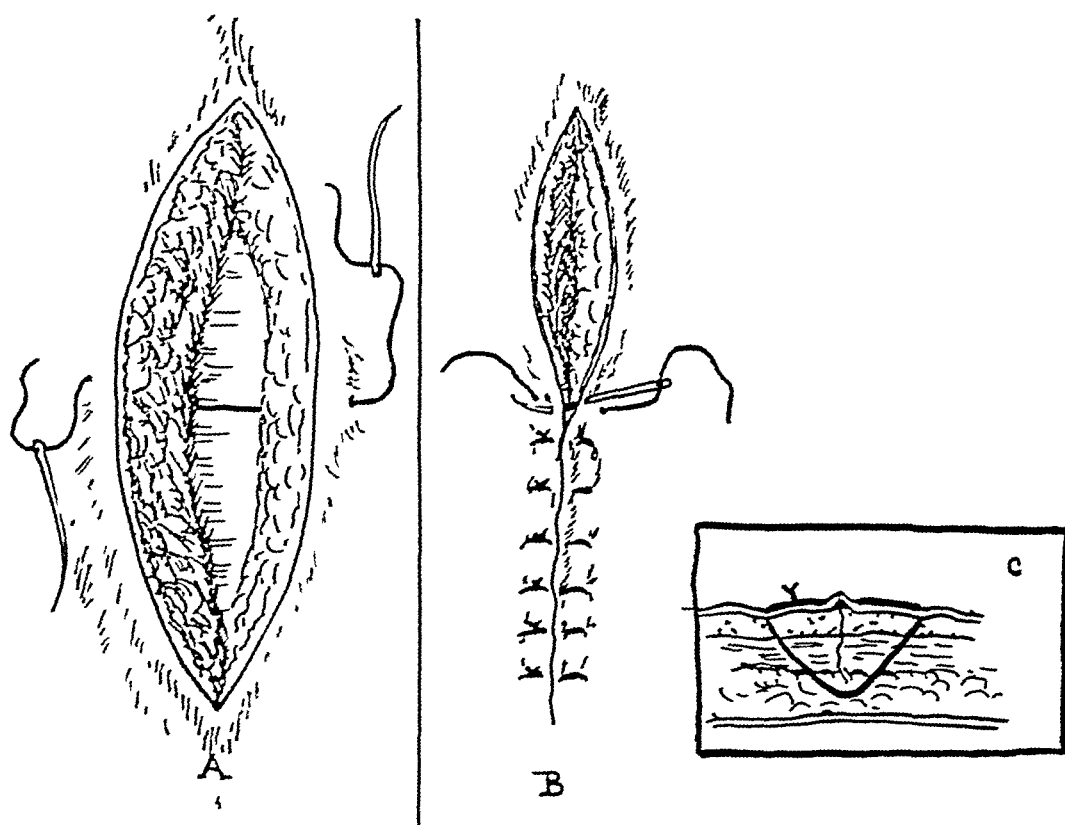


FIG 2—The interrupted on end mattress suture (Redrawn from Davis and Traut, 1930) (A) Note the distance between the line of incision and the point of entrance and emergence of the stitch and also its depth. Two half curved Corneal needles are used which slip through the skin easily. The needle for the superficial portion of the stitch is usually somewhat finer so that it will pass through the epithelial margins without tearing. (B) Shows several stitches in place and tied and the needle passing through the epithelial margins, turning them out so that there will be no inverting and no overlapping. (C) Shows a profile view of the interrupted vertical mattress suture. Note the points of entrance and emergence, the depth of the stitch and the turning out of the margins.

reverse it or rethread it for the superficial portion of the stitch. The first, or deeper part of the stitch, can be made to include as great a depth of the subcutaneous tissue as is desired (Fig 2)

I have found that the finest approximation can be made by picking up

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\*The needles I have found most satisfactory for skin closure with the on-end mattress suture are the half curved, No 16 or No 17, for the deeper portion of the suture as this is a larger needle, and No 20, which is considerably smaller, for the superficial part of the stitch. Occasionally, I use a small full curved cutting needle for either the deep or superficial portion of the stitch, or have a full curved needle on one end of the suture material and a half curved on the other.

with the second part of the stitch only the most superficial portion of the incised edges rather than by including the fairly deep bite into the corium. It is easier to take a deeper bite but the closure is not so accurate. In dealing with the mucous membrane of the mouth, vagina and bladder, the full thickness of the mucosa should be picked up in the superficial section of the stitch.

Dr E Bonnot,<sup>3</sup> of St Louis, in 1915 described the interrupted on-end or vertical mattress sutures as "A New Stay Stitch for Deep Wounds" and speaks of it as "a mattress suture on its side." He puts the suture in quite

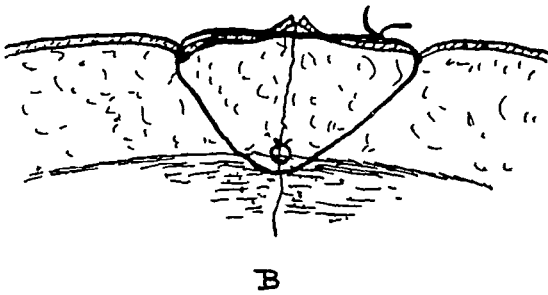
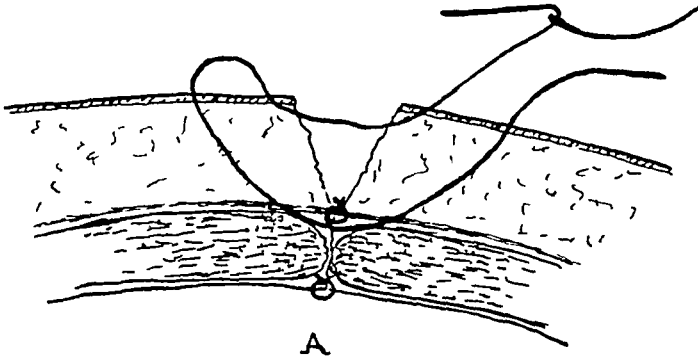


FIG 3—A new stay stitch for deep wounds (Redrawn from Bonnot, 1915) (A) The needle is inserted about an inch from the edges of the wound through and including the edges of the deep fascia and out on the other side at the same distance from the wound (B) The needle is then passed back through the skin one fourth of an inch from the edges and tied on one side of the wound

far away from the skin edges and suggests supplementary superficial skin sutures if necessary (Fig 3)

The interrupted on-end mattress suture is sometimes called the Stewart suture after Dr George David Stewart,<sup>16</sup> of New York. After seeing Doctor Bonnot's article, Doctor Stewart<sup>15</sup> wrote "Dr Edmund Bonnot describes and illustrates a stitch which I have been using for many years and which has been adopted by many of my colleagues. By some it is named for me, but it is not mine. I saw it described years ago, but have forgotten the name of the maga-

zine and the author, remembering only that it came from one of the nearer Southern States, perhaps Virginia." Doctor Stewart says further on that he has "always taken pains to disclaim any credit for its invention." It seems likely from what has been said above that it was Doctor McMillen's article to which Doctor Stewart referred.

There is another suture which has also been called the Stewart suture, which was first described as "a combined retention and coaptation suture," in the second edition of the "Manual of Surgery" by Dr F T Stewart,<sup>14</sup> of Philadelphia, in 1911. This suture is certainly an excellent one and is based on the on-end mattress type, but it takes in a much wider and deeper bite of skin and subcutaneous tissue in the second part of the stitch, requires two knots, and does not give as fine a skin closure as the suture devised by Doctor McMillen (Fig 4)

## VERTICAL MATTRESS SUTURE

Dr Vilhay Blair,<sup>2</sup> of St Louis, has used the interrupted on-end mattress suture for years and illustrated it as a palate flap suture which will not allow

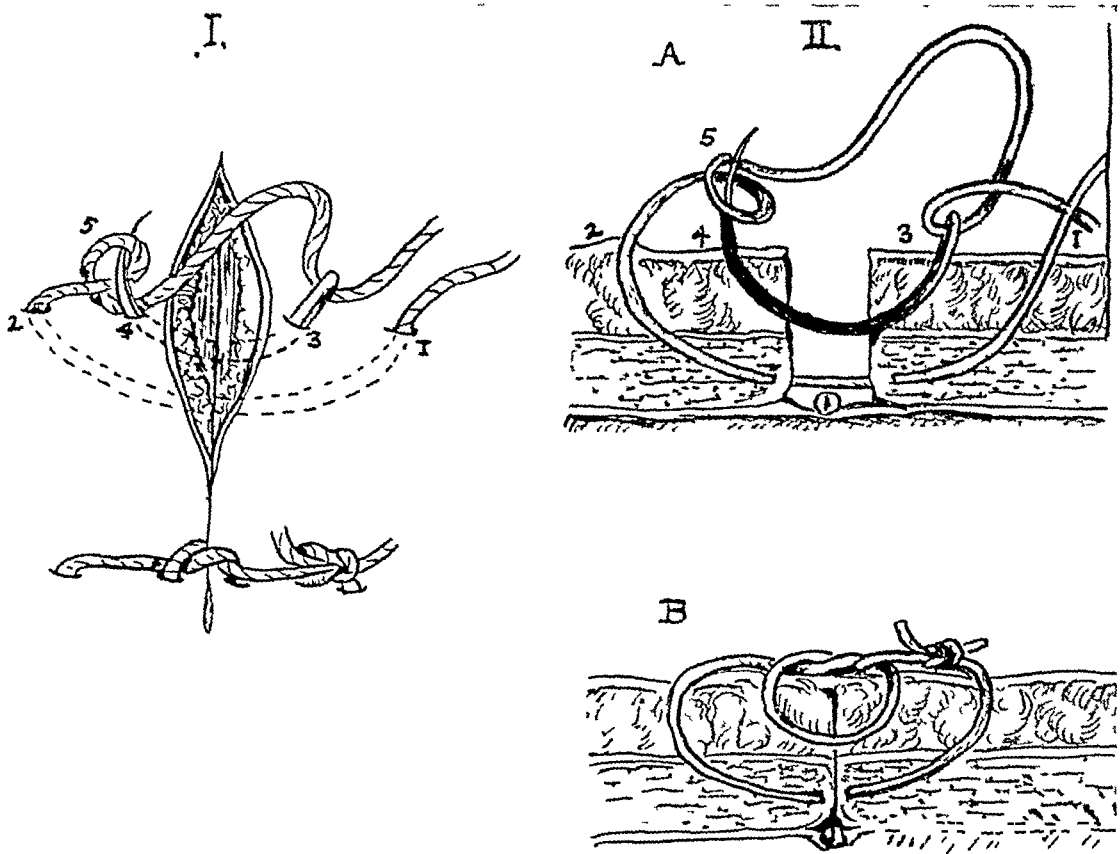


FIG 4—The F T Stewart suture (I Redrawn from the second edition of Stewart's Manual of Surgery, 1911) (II Redrawn from the sixth edition, Stewart and Lee, 1931) The needle is inserted at 1, brought out at 2, reinserted at 3, and emerges at 4, passing through the loop at 5. When drawn tight it holds the wound edges firmly together and prevents inversion of the skin.

cut edges of mucous membrane to overlap, as early as 1912, and also in later publications (Fig 5). All the men who have worked with me for the

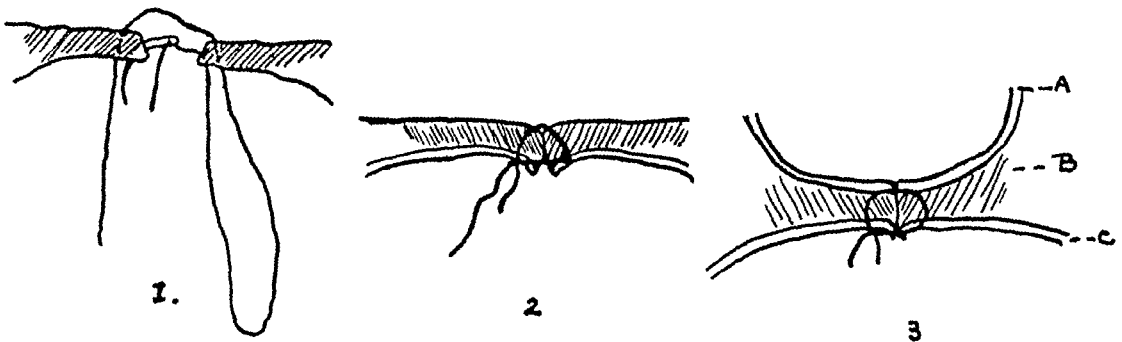


FIG 5—Illustrating the on-end or vertical mattress suture used in suturing mucoperiosteal flaps in the repair of a congenital cleft of the palate (Redrawn from Blair, 1912) (1) Shows the deep portion of the stitch going through the full thickness of the mucoperiosteal flaps and the superficial portion going through the mucous membrane. (2) Shows the suture drawn snug and the approximation of broad raw surfaces of the flaps and eversion of the mucous membrane. (3) The vertical mattress suture in the soft palate. (A) Mucosa of the nasopharynx. (B) Soft palate tissue. (C) Oral mucosa.

last twenty years are also familiar with this stitch, and a number of other authors have described and illustrated it.

*The Continuous Type*—In order to show the difference between the con-

tinuous mattress skin suture and the continuous on-end mattress suture, I will illustrate with the following (Fig 6)

Dr John A Wyeth,<sup>18</sup> of New York, in his text-book published in 1887, shows a continuous mattress suture for closing the skin and says "the mattress suture shown is

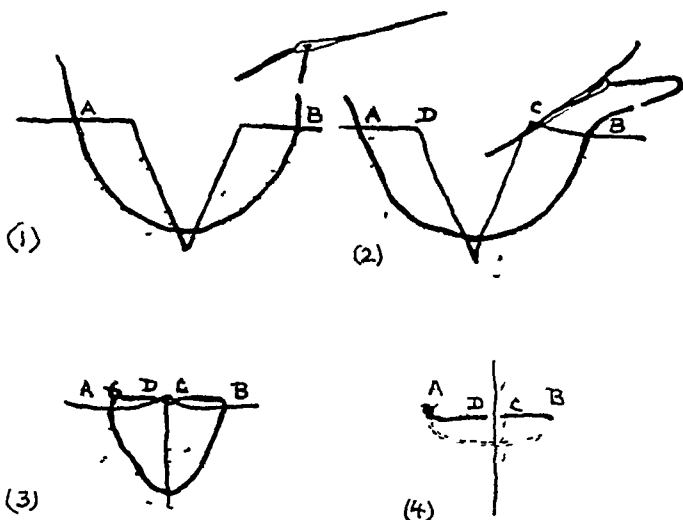


FIG 6—A useful skin suture (Redrawn from Arthur Edmunds 1918) (1) The suture is passed from A across the wound to B taking up if required, the whole thickness of the fatty layer (2) The needle which should be a fine one is then inserted through the extreme edge of the wound C passing from without inwards and taking up only the very minimum of tissue then passed through the opposite lip of the wound D from the wound to the skin surface This stitch is identical with the interrupted on end mattress suture of McMillen

practically obsolete and possesses no advantages which do not belong to the interrupted or continuous methods" It may be inferred from this that the use of the continuous mattress suture placed flat was even then not a new one

In 1912, Dr Willard Bartlett,<sup>1</sup> of St Louis, described "a continuous mattress skin suture," which is identical with that described by Wyeth (Fig 7) He summarized its advantages as follows

"Being a continuous stitch it lends greater speed to an operator than the interrupted stitch It acts as a good tension stitch with little possibility of cutting through the tissue It leaves no cross scars Small longitudinal scars are left, but these are generally not so unsightly It insures the desired approximation of the epithelial surfaces, prevents the turning-in tendency of the skin and thus guards against infection, through this source, of the deeper structures of the wound"

This suture is much superior to the ordinary continuous skin suture, but differs materially from the continuous on-end mattress type as will be seen As far as I<sup>5</sup> 6 can ascertain, the continuous on-end or vertical mattress suture was first described by Dr C S White,<sup>17</sup> of Washington, D C, in 1917, and he spoke of it as the continuous vertical mattress suture (Fig 8) His description of the stitch was as follows

"The suture should have a knot or small loop tied in the long end, or fixed by a split knot and begun by taking a deep suture to include the entire thickness of the skin, from one side of the incision to the opposite, about one centimetre from the edge The needle is then reversed in the holder and the suture passed obliquely toward the other side, or the side on which the suture was started, barely engaging the edges of the wound The needle is then introduced a trifle lower, on the side on which it originally entered, one centimetre from the edge and the first deep suture is repeated These deep and superficial sutures are continued until the wound is closed, drawing up the thread gently as each suture is completed" Doctor White used No 00 or No 000 chromic catgut

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I, personally, never use catgut for suturing the skin and feel that in closing wounds, particularly on the face, that a much less conspicuous scar can be obtained by a closure with horsehair, fine waxed silk or some other fine non-absorbable suture material, and that there is considerably less chance of superficial infection

Dr J Sarnoff, of Brooklyn, in 1929 described "A New Hemostatic, Approximation and Tension Suture" as follows

"In the ordinary continuous stitch one passes the needle through the skin a distance away from the skin edge on one side until it reaches the opposite side of the

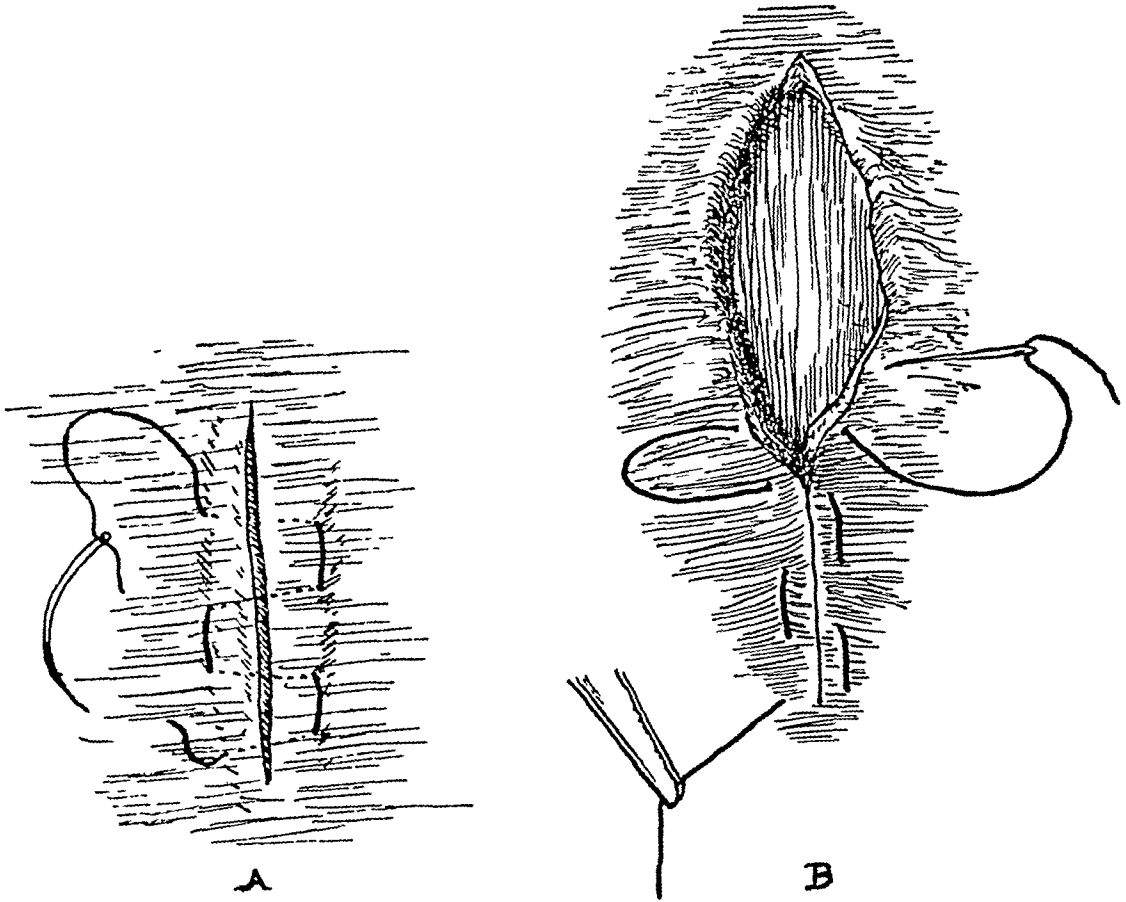


FIG 7—Continuous mattress skin suture (A) (Redrawn from Wyeth, 1887) (B) (Redrawn from Willard Bartlett, 1912) The needle is introduced a little to one side at the very end of the wound and passing under the skin is brought out at a point directly opposite. It is then reversed and passed back through both lips, being inserted a little higher along the wound. Sufficient tension is exerted to permit an easy falling together of the wound edges. This procedure is repeated until the wound is closed. It will be noted that the purpose of this suture is to keep the skin edges from turning in and that it is inserted in exactly the reverse way from the continuous mattress intestinal suture of Cushing which is designed to turn in the margins.

incision the same distance away from the skin edge. Then the thread with the needle is carried over the line of incision in an oblique or straight direction to the opposite side and the same process is repeated. In this new suture, instead of carrying the needle over the line of the skin incision to the opposite side as mentioned above, the needle as it reaches the extreme edge of the skin at the line of the incision is first passed through these free edges and is then continued as in the ordinary stitch."

Doctor Sarnoff, in 1931, in a very excellent summary of the advantages of this suture, which is identical with the continuous on-end or vertical mattress suture described by Doctor White says

"(1) The suture is simple and speedy of execution. It is fool-proof, the edges cannot invert or evert.

"(2) The suture evenly approximates the deep parts of the skin as well as its finest cut edges. It thus provides two wide opposing raw surfaces for healing with a resulting firm subcutaneous as well as cutaneous union of the cut edges. The deep part of the suture takes away any tension on the skin edges and the scar, therefore, does not stretch and widen out, as happens with the average suture.

"(3) The suture prevents puckering between the stitches, which is unavoidable with interrupted sutures and it maintains an even and constant tension on all tissues at the line of suture. One may compare it to a zipper, with its many advantages over buttons.

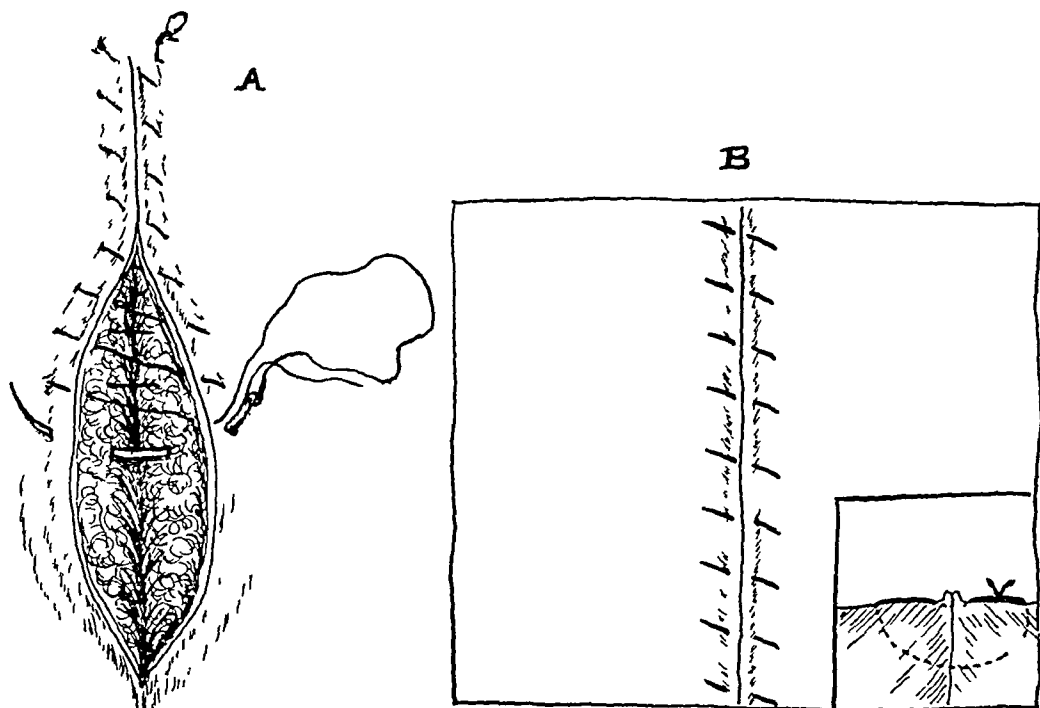


FIG 8—(A) The continuous vertical mattress suture (Redrawn from C S White, 1917) The suture is fixed by any desired method. Starting about one centimetre from the edge a deep suture including the entire thickness of the skin is taken from one side of the incision to the other as in any continuous stitch emerging the same distance from the wound edge on the opposite side. The needle is reversed in the holder and the suture is passed obliquely toward the other side barely engaging the edges of the wound. The needle is introduced, a trifle lower down and exactly the same process is repeated. The deep and superficial portions of the suture line are continued until the wound is closed drawing up the thread gently as each section of the suture is completed. (B) A combined superficial and deep continuous suture (Redrawn from Sarnoff, 1929) Compare this drawing with A and it will be found that the sutures are identical and the same description will answer for both.

"(4) The suture effects complete hemostasis at the suture line and obliterates dead space, factors conducive to primary union in its fullest sense in all clean cases.

"(5) The suture is removed with great ease, and the scar left after healing is almost invisible."

*The Button-hole Modification of the Continuous On-end Mattress Suture*  
—In January, 1918, Dr Fowler Roberts,<sup>10</sup> of Indianapolis, illustrated a "stitch for the closure of skin wounds," which he described as "a series of on-edge mattress sutures made continuous by looping the suture as in the button-hole stitch instead of tying as in the interrupted on-edge mattress suture" (Fig 9). This modification of the continuous type of on-end

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mattress suture is an excellent one and can be used in closing wounds where there is somewhat more tension than in the ordinary incised wound

Mr Arthur Edmunds,<sup>7</sup> of London, in February, 1918, described and illustrated a typical single or interrupted on-end or vertical mattress suture, which is exactly like the suture described by Doctor McMillen<sup>6</sup> and also a continuous type of on-end mattress suture which is identical with that described by Doctor Roberts. He says of the interrupted type that there are two parts to the stitch, the deep part which obliterates any dead space in the wound, and the superficial part, which holds the extreme edges of the wound and prevents their inversion, actually slightly elevating them, although leaving their epithelial margins in accurate apposition

*Remarks*—When we speak of closure of the skin, we also mean in many instances the closure of the closely associated subcutaneous tissue. Unless

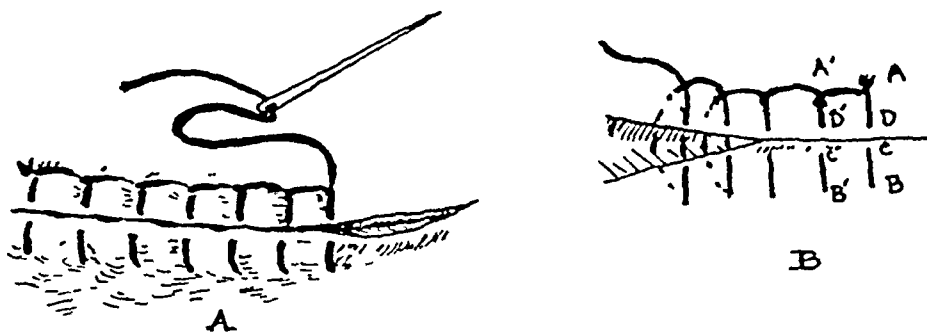


FIG 9—(A) Continuous on edge mattress suture of the buttonhole type (Redrawn from Fowler Roberts, 1918) The suture is begun as an ordinary single or interrupted on end mattress suture, but instead of tying and keeping it the interrupted type, the thread is looped as in the buttonhole stitch and the process is continued until the wound is closed. (B) The button hole type of continuous on end mattress suture (Redrawn from Arthur Edmunds, 1918) The needle is inserted at A, and is passed as deeply through the fat as may be necessary and emerges at the corresponding point B on the other side of the wound. The needle is then passed through the extreme edge of the wound and tied but not cut. The next stitch is inserted in exactly the same manner, A' to B', leaving the loop of thread, AA', lying close to the skin and parallel to the wound. Then through the lips of the wound C' to D', finally passing under the thread AA' and drawing the wound together. This process is continued until the closure is completed. It will be noted that these two sutures are identical although started in the drawings at opposite ends of the incisions.

this closure is very carefully done and the stitches are placed correctly and tied with the exact amount of tension, there may be overlapping or inversion of some portion of the skin edges. This may delay final healing and may also make an uneven scar which, in a conspicuous position such as the face, may subsequently be very annoying. A carefully sutured wound will heal more rapidly and strongly than one in which the approximation has been indifferently done. Asepsis, gentle handling of tissues, complete hæmostasis, elimination of dead spaces and accurate approximation without tissue strangulation are the factors which must be striven for.

In plastic surgery I have found the single interrupted type of the on-end mattress suture to be most satisfactory in closing all skin wounds and especially advantageous in closing irregular wounds, also wounds where there has been destruction or excision of tissue, and where there is more tension on the edges than there would ordinarily be in closing a simple incised wound. The stitches can be removed separately, which is an advantage, the stitch, if properly placed, seldom if ever causes strangulation of tissue. It slightly



everts the cut edges and prevents overlapping or inversion. The closure is strong, as broad raw surfaces the full depth of the suture are brought in close approximation. The scar is much less conspicuous than that following any other type of closure with which I am familiar. I have been able to get good approximation in wounds which could not be satisfactorily closed by any other type of suture. In accident work or where small growths have been excised, and in fact in every closure both in skin and mucous membrane where the edges can be brought together, I usually employ this type of suture. The difficulty, as with any interrupted stitch, is that it takes more time than the continuous type. Of course, reasonable speed in operating or in closing a wound is desirable, but it is far more important to handle tissues with consideration and use meticulous care in getting a good closure than it is to shorten the operating time by a few minutes.

Where there has been loss of tissue and the edges do not fall together as would those of a simple incised wound, in placing the interrupted on-end mattress suture, I frequently alternate silk and horsehair, or supplement a horsehair closure with a few waxed silk sutures.

In closing some wounds, it may be sufficient to take a few rather deeply placed interrupted on-end mattress sutures, at intervals along the length of the incision, to give strength and even approximation and in between these to place very superficial simple interrupted sutures through the skin edges.

One should begin to remove the interrupted on-end mattress sutures as early as twenty-four hours, if the wound is on the face or in some other conspicuous area, and all of them should be out by the third day. The strain on the wound edges is relieved by strips of crepe lisse held in place by collodion, and this type of dressing is continued for about ten days. In less conspicuous portions of the body, the stitches are taken out as they loosen, usually all being removed by the tenth day.

It is seldom that the continuous on-end mattress suture is employed on the face or in other conspicuous positions. This type of suture should be removed anywhere from the seventh to the tenth day depending on conditions.

I use the single or interrupted on-end mattress suture a great deal more frequently than I do the continuous variety as the wounds with which I have to deal in plastic surgery are seldom of the simple incision and closure kind, and the tissues to be sutured are often infiltrated with scar.

I prefer the single or interrupted type as each suture is a separate unit and if any single suture should break or become untied only a small portion of the closure would be affected. Multiple sutures naturally give a stronger, safer closure than a continuous suture which depends on a single thread. When the continuous suture is used, if the tissue should for any reason tear out at any point, or the single thread break, then the result on the entire suture line might be jeopardized. Nevertheless, I have found that in suitable cases the continuous vertical mattress suture is most useful in closing line incisions and it gives in skin and mucous membrane a good strong closure with an inconspicuous scar.

## VERTICAL MATTRESS SUTURE

The continuous type can be used to advantage in closing any line incision in skin or mucous membrane or in fact anywhere, that a continuous suture can be employed and gives a smoother, more even and stronger closure than the ordinary suture. Its application takes very little longer than the ordinary continuous suture, but its advantages, especially in closing incisions in skin and mucous membrane, are obvious.

By the use of the on-end or vertical mattress suture, either interrupted or continuous, dead spaces between the wound edges can be eliminated. In spite of the ease and accuracy with which the skin or mucous membrane can be closed with the on-end mattress suture of either type, there have been, up to the last few years, comparatively few surgeons who have realized the value of this suture.

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# THE WATER REQUIREMENTS OF SURGICAL PATIENTS

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THE importance of water to the body in conditions of health and disease is generally recognized. We have reported studies<sup>1</sup> on the factors of water loss during the time of operation and in the recovery period. We wish to present here an amplification of those observations on water metabolism to cover longer periods of time. To facilitate an understanding of the terms and methods employed in the investigation, a statement of the general factors of water balance will briefly be given. Due to the nature of many surgical conditions and their treatment, an absolutely accurate study of water exchange cannot be made on surgical patients over long periods of time and some modifications of the standard methods evolved by Newburgh and his associates<sup>2, 3</sup> were found necessary. However, the observations made are sufficiently accurate to permit valuable deductions.

There are two general sources of water available for the body, the exogenous, comprising the water of the food and the water drunk, and the endogenous, comprising the water of oxidation and the preformed water. Solid food averages 80 per cent water content. From this source a routine maintenance diet or the usual house diet provides an average of 1,000 cubic centimetres of water a day and the hospital soft diet about 500 cubic centimetres of water a day. This factor obviously plays a small part in the post-operative fluid intake for the first three days, after that time it assumes a more important rôle.

The fluid drunk varies greatly from day to day, depending on the thirst of the individual, normal volumes ranging from 800 cubic centimetres to 2,000 cubic centimetres daily.

The oxidation of the food within the body forms water in proportion to the amount of the material consumed. The oxidation of one gram of protein yields 0.4 gram of water, of fat, 1.07 grams of water, and of carbohydrate, 0.6 gram of water. The determination of this portion of water assumes an accurate knowledge of the amount of protein, fat and carbohydrate being oxidized. This, the metabolic mixture, usually does not correspond to the food intake since the metabolism is seldom exactly the same as the calorific value of the diet, and body tissue may be built up or oxidized to care for the difference. The water of oxidation averages from 200 grams to 400 grams for persons at light activity. The accurate determination of water of oxidation in the sick surgical patient is impossible and is the chief reason for our inability to study water exchange with complete accuracy in this group of patients. This difficulty may arise through changes in the patient's diet, because of the disease and treatment, and sometimes because of changes in the metabolism characteristic of the disease or associated with fever. It has

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been found,<sup>2</sup> however, that the sum of the weight of the water content of a normal diet and the weight of its water of oxidation is approximately 90 per cent of the total weight of the diet. This method of calculating the water content of the food and its water of oxidation was used in our study. The error probably never exceeded 200 grams a day.

Preformed water is the body water that is attached to the tissues in the normal manner and is set free when tissue is oxidized. This amount is usually so small as to have no important bearing on the total water balance, but in starvation it may reach the amount of 250 grams a day.

Water is lost normally in the urine, in the fæces, through the skin and lungs, and in abnormal conditions, by vomiting, from intestinal or biliary fistulæ, by diarrhœa, and by wound secretions.

Normal kidneys act so that daily waste products are excreted in a small volume of urine with a high specific gravity or in a larger volume of urine of lower specific gravity, depending on the amount of water available. Waste products excreted by the kidney in solution average about thirty-five grams daily.<sup>4</sup> There must be at least 600 cubic centimetres of urine excreted daily to carry away these solids in solution. Normal urine volumes are generally well over 95 per cent water.

The water lost in fæces of normal man is usually not more than 200 cubic centimetres, varying ordinarily from 60 to 150 cubic centimetres daily. This loss is normally, therefore, trivial compared to the total output. In surgical patients, however, loss from the gastro-intestinal tract by vomiting, from intestinal or biliary fistulæ, or by diarrhœa may reach large amounts that will in a short time lead to dehydration.

There is a continuous insensible loss of water from the lungs and skin that is always a large amount and may be the greatest part of outgoing water even under normal conditions. This loss is largely concerned with the regulation of body temperature and over a considerable range of body activity short of physical labor this evaporation of water accounts for about 24 per cent of the heat lost. Newburgh and his associates<sup>5</sup> have shown that this water vapor varies from 85 per cent to 100 per cent of the total insensible loss of weight, shifting with the composition of the metabolic mixture oxidized. The other component of the insensible loss is the difference between the weight of outgoing carbon dioxide and the incoming oxygen. Studies<sup>5</sup> of this insensible loss at normal activity show the daily quantity to average from 1,000 cubic centimetres to 1,550 cubic centimetres. We considered, then, in our calculation the total insensible loss of weight as entirely water with the introduction of a slight but practically negligible error.

The procedure carried out in each case studied is shown in Table I. The patients were under constant day and night supervision by one of us to insure accuracy. In short, the method was designed and carried out to determine as accurately as possible under the circumstances the amounts and sources of fluids of intake and output.

In Table II are shown the components of water exchange on a simple surgical case. The patient was a girl of twelve on whom a short operation for the closure of a parotid

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TABLE I  
*Outline of Procedure*

WEIGHT IN GRAMS OF -	NAME-----	DATE-----
1 Patient * Time-----	Weight of patient + Bradford frame + coverings + dressings Weight of " " " "	-----
2 Food	Breakfast	Dinner
Tray + dishes + food	-----	-----
Tray + dishes	-----	-----
	+	+
3 Water drunk	Callon thermos Jug with drinking tube through notched cork	Filled H <sub>2</sub> O ----- Remaining H <sub>2</sub> O -----
	4 Urine	5 Stool
	6 Vomitus	7 Special in
	8 Special out	
Covered pail + 24 hour specimen	-----	-----
Covered pail	-----	-----
	Sp gr	-----
9 Blood loss in O R ( 4 )	10 Surgical specimen	11 Total intake
12 Sensible total output	13 Insensible loss	14 Total output
	Weight patient start-----	
	+ total intake -----	
	minus -----	
	Weight patient end -----	
	+ sensible total -----	
	output -----	

fistula was performed under nitrous oxide and oxygen anaesthesia. It will be observed that on the two days prior to operation the water of intake, from the food eaten and water drunk, was approximately 3,000 grams. The insensible loss for this period was close to 900 grams a day. This left about 2,000 grams of water for kidney function, consequently the urine is about that amount with a low specific gravity. Therefore, on these days she is in water balance as shown by a comparison of the total intake and

TABLE II

Date	1932	Dec.14	Dec.15	Dec. 16	Dec.17	Dec 18
Weight in grams of.-				Opera- tion		
Patient	30413	30520	30267	29825	30339	
Food	1122	1182	215	1081		
Water drunk	2124	1785	708	1926		
Urine	2245	1982	222	1670		
Sp.gr.	1.011	1.006	1.030	1.006		
Stool	0	185	0	0		
Vomitus	0	0	269	0		
Blood			15			
Insen.loss	894	1053	859	823		
Max temp.°F.	98.6	99.2	98.6	99.0		
Total intake	3246	2967	923	3007		
Total output	3139	3220	1365	2493		

A girl aged twelve Operation, closure of parotid fistula under nitrous oxide and oxygen anaesthesia

output and confirmed by the constant body weight. On the third day she was operated upon and in spite of the total intake being lowered to about 1,000 grams, the insensible loss was unchanged. The water lost by vomiting and the lessened intake is all reflected in the small amount of urine of a maximal specific gravity. This volume of urine is too low to excrete urinary solids for that day. The following day the intake was back to the pre-operative level and the urine volume was increased with a consequent reduction

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of its specific gravity. The weight loss noted on the day following operation represents water abstracted from the body's interstitial water. On the following day (December 17) the process is reversed and the patient gaining weight. We wish to emphasize especially that the insensible loss remains constant while the lowered intake is reflected in the urinary water.

In Table III are shown the observations on another simple surgical case. A healthy woman of forty-one years was operated upon for an inguinal hernia under nitrous oxide and oxygen anaesthesia. On the day prior to operation the total intake of available water was low while the output was nearly 1,000 grams more than the intake. Such differences are frequently found on any one day in normal people. On the day of operation there was a slight increase in the insensible loss and a marked diminution in the amount of

urine with a consequent rise of its specific gravity. The intake on this day was too small but no water was given except orally since she was expected to take adequate amounts soon. On the following day a larger intake resulted in a rise of urine volume to a satisfactory level. One again notes the constancy of the insensible loss with the reflection of the diminished intake in the lessened amount of urine.

Table IV gives the results of the observations on a boy, eleven years old, weighing 28.8 kilograms

Date. 1933	Jan.11	Jan.12	Jan.13	Jan.14
Weight in grams of:-		Opera- tion		
Patient	67990	67170	66615	66388
Food	1541	0	486	
Water drunk	842	1561	1949	
Urine	2127	693	1647	
Sp.gr.	1.012	1.026	1.007	
Stool	0	0	0	
Vomit	0	213	0	
Blood	0	22	0	
Insens.loss	1076	1188	1015	
High temp.°F.	99.0	99.6	99.2	
Total intake	2583	1561	2435	
Total output	3203	2116	2662	

A woman, aged forty-one years. Repair of a right inguinal hernia under nitrous oxide and oxygen anaesthesia.

(sixty-three pounds) who gave a history of an attack of acute appendicitis three days prior to the time of entrance to the hospital. He had been purged before coming to the hospital. On entrance he presented a typical clinical picture of peritonitis complicating acute appendicitis. It was decided to treat him conservatively (Ochsner method) and in the following twelve days he was restored to normal without operation. During the first nine days nothing was given by mouth, the entire fluid intake being maintained intravenously. Each day he received 1,000 cubic centimetres of normal saline, the remainder of the fluids as 5 per cent glucose solution. The water losses were largely urine and insensible loss with a small amount of vomitus. The insensible loss was remarkably constant at a figure just short of a litre a day during the febrile period. This loss was high for a person of his size and undoubtedly due to the increased heat production of fever. That the intake was adequate is shown by the urinary output which averaged more than two litres a day with a low specific gravity. During the entire period of study there was a daily loss of weight of about 250 grams, which can be accounted for by oxidation of tissue above the calorific intake. A comparison of the intake and output day by day shows a satisfactory water balance for the entire period. It is of some interest to note that there was no movement of the bowels until the tenth day, when water was given by mouth.\*

\* We believe that the use of enemas in this group of patients is unwise and this and other similar observations show that no harm comes from failure of the bowels to move while under this treatment. When food or drink is eventually taken into the gastro-intestinal tract, the bowels move again.

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In Table V are shown the observations on a young man of seventeen years with an acute exacerbation of an extensive chronic osteomyelitis of the right tibia complicated

TABLE IV

Date	1933	Feb 20	Feb 21	Feb 22	Feb 23	Feb 24	Feb 25	Feb 26	Feb 27	Feb 28	Mar. 1	Mar. 2
Weight in grams of -												
Patient		28815	28305	28091	28480	27925	27621	27642	27586	27052	26751	26437
Food		0	0	0	0	0	0	0	0	0	0	0
Water drunk		0	0	0	0	0	0	0	0	0	0	624
Intravenous		3370	3755	3221	3125	3710	3635	3372	3178	3250	2310	
Urine		2622	2809	1857	2605	2985	2694	2187	2797	2777	2456	
Sp gr		1 005	1 004	1 005	1 007	1 009	1 008	1 008	1 004	1 002	1 009	
Stool		0	0	0	0	0	0	0	0	0	50	
Vomitus		170	191	22	94	66	62	52	0	0	0	
Insens loss		1088	969	953	981	963	858	1189	915	774	742	
Max temp °F		100 6	100 0	103 0	102 0	101 8	100 6	99 0	99 2	99 4	98 8	
Total intake		3370	3755	3221	3125	3710	3635	3372	3178	3250	2934	
Total output		3880	3969	2832	3680	4014	3614	3428	3712	3551	3248	

Boy, aged eleven Acute appendicitis, duration three days with general peritonitis Treated conservatively (Ochsner) without operation

by a purulent arthritis of the knee-joint Positive blood cultures of *Staphylococcus aureus* were obtained on two occasions prior to the disarticulation of the knee, done on March 8

The intake was by mouth in the form of food and drink except the day before, the day of, and the day after operation, when it was given intravenously as blood and 5 per cent glucose solution The output was through the insensible loss and urine except for a small amount of vomitus on one occasion The insensible loss was high, reaching 2,500 grams on the day of the operation We have shown in a previous report<sup>1</sup> some of the factors that increase this form of water loss during the operation For the febrile stage of his disease, the heat production was high and consequently the loss of heat by evaporation must be high with a marked increase in the water lost through this channel With an improvement in his condition and with a diminution of the fever this loss slowly fell It is wise to think of the insensible loss in a septic patient as amounting to about two litres a day The urinary output was usually kept well over two litres a day with a low specific gravity

In Table VI are presented the observations on a man of thirty years with a

TABLE V

Date	1933	Mar. 7	Mar. 8	Mar. 9	Mar. 10	Mar. 11	Mar. 12	Mar. 13	Mar. 14	Mar. 15	Mar. 16	Mar. 17	Mar. 18	Mar. 19	Mar. 20
Weight in grams of -			Operation												
Patient		51378	52164	46818	45788	44151	43252	42816	42531	41988	41879	41088	40640	40579	40438
Food		192	0	310	540	833	983	1425	1084	1255	1242	1250	1692	1472	
Water drunk		1332	43	1045	3651	2812	2113	2810	2401	3310	2217	2216	2414	1176	
Intravenous		4691	6757	5706	0	0	0	0	0	0	0	0	0	0	
Transfusion			515												
Urine		3767	4218	6048	4031	2225	1437	2637	2264	3102	2556	2205	2816	1416	
Sp gr		1 008	1 011	1 006	1 004	1 007	1 013	1 008	1 009	1 006	1 008	1 010	1 007	1 012	
Stool		0	0	0	87	544	333	240	224	103	206	239	80	133	
Vomitus		64	0	0	0	0	0	0	0	0	0	0	0	0	
Blood			527												
Specimen			5059												
Insens loss		1598	2457	2043	1710	1775	1772	1644	1540	1469	1488	1464	1277	1240	
Max temp °F		103 8	103 0	103 8	101 6	101 2	100 2	100 0	100 6	99 8	99 8	99 0	99 4	99 6	
Total intake		6215	7315	7061	4191	3645	3096	4236	3485	4565	3459	3466	4106	2648	
Total output		5429	12661	8091	5828	4544	3542	4521	4028	4674	4250	3908	4173	2889	

Male aged seventeen Acute exacerbation of chronic osteomyelitis of tibia with purulent arthritis of knee Operation disarticulation at knee under nitrous oxide and oxygen anaesthesia

pulmonary abscess Six days before our studies began he had had ribs resected and the pleura packed preparatory to drainage of the lung abscess which was done on March 4 He was septic and ran a fever of about 100° F Intake was entirely by mouth The outstanding interest in this case is the daily insensible loss that averages above two litres, the maximum reaching 2,729 grams during the acute stage of the disease In spite of this high insensible loss, the urine was maintained at a volume of

## WATER FOR SURGICAL PATIENTS

over 2,000 grams a day On the day of operation it will be noticed that 165 grams of serum were aspirated from the wound The loss of fluid from the wounds was trivial in the other cases studied but it is clear that many surgical patients with burns, large wounds or draining abscesses might lose amounts of fluid from this channel that over the course of time would be important and in such cases allowance for this loss must be made

TABLE VI

Date 1923	Feb. 23	Feb. 24	Feb. 25	Feb. 26	Feb. 27	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4	Mar. 5	Mar. 6	Mar. 7	Mar. 8	Mar. 9	Mar. 10	Mar. 11
Weight in gm of										Oper- ation							
Patient	60603	60018	59634	59464	58705	58.13	57344	56900	57051	57144	56849	57226	57003	56503	56261	56440	56171
Food	1480	1577	1728	1662	1667	1518	1102	1727	1802	577	1676	1518	1659	1681	1626	1637	
Water drunk	2792	3459	3584	3275	2327	3970	2321	2331	2753	2320	2249	2944	2235	2372	2808	2715	
Urine	2700	2934	3164	3071	1960	3581	2639	2520	2269	1559	1958	2733	2271	2435	1231	2437	
Sp gr	1.014	1.011	1.011	1.012	1.018	1.009	1.012	1.009	1.017	1.013	1.015	1.011	1.013	1.011	1.017	1.011	
Stool	304	125	0	705	209	236	0	113	185	0	0	105	111	0	0	346	
Drng										165							
wound										103							
Blood										10	4	5	2	18	21	22	
Sputum	124	90	55	47	60	43	57	30	57								
Insens loss	2729	2221	2263	2172	2152	1937	1131	1914	1573	2329	1956	1726	1940	1942	2112	1676	
Max temp °F	101.4	100.0	100.4	99.8	100.0	99.6	99.2	99.6	99.6	100.0	99.6	99.0	99.8	99.5	99.8	99.6	
Total intake	5272	4996	5312	4837	3989	5488	6022	5658	4555	2317	4225	4502	2954	4653	4444	4212	
Total output	5857	5380	5482	5596	4391	5857	5887	6087	664	4210	228	4235	4454	4235	4200	4481	

Male, aged thirty years Pulmonary abscess Preliminary rib resection performed on February 17, six days before this study was started Pulmonary abscess drained on March 4

Table VII gives the observations on a man, fifty-one years old, with exophthalmic goitre of moderate severity His basal metabolic rate was a +27 per cent the day before operation A subtotal thyroidectomy was done on February 16 Water was taken in by food and drink during the entire time of observation excepting food on the day of operation and the day following A subpectoral infusion was given on the

TABLE VII

Date	1923	Feb. 14	Feb. 15	Feb. 16	Feb. 17	Feb. 18	Feb. 19	Feb. 20	Feb. 21	Feb. 22
Weight in grams of -				Oper- ation						
Patient		53543	54194	54662	55473	54189	53265	53965	53999	53893
Food		1711	1767	0	0	1545	1459	1492	1868	
Water drunk		2943	3009	611	2829	2451	2062	2595	2576	
Hypodermoclysis				2065						
Urine		1885	2513	735	2649	3896	2064	2101	2768	
Sp gr		1.013	1.013	1.021	1.007	1.007	1.011	1.011	1.010	
Stool		281	40	0	0	183	196	124	107	
Vomitus		0	0	85	0	84	0	0	0	
Blood				100						
Specimen				61						
Insens loss		1837	1954	1886	1464	1758	1559	1828	1675	
Max temp °F		99.6	99.8	99.8	101.2	100.8	99.6	99.0	99.0	
Total intake		4654	4776	2676	2829	4996	4521	4087	4444	
Total output		4002	4207	2867	4113	5921	3819	4053	4550	

Male, aged fifty one, with exophthalmic goitre Basal metabolic rates +50 per cent, +27 per cent Subtotal thyroidectomy under nitrous oxide and oxygen anæsthesia on February 16

day of operation Water left the body mainly by the insensible loss and the urine The urinary output was adequate to keep the specific gravity low except on the day of operation when it fell in amount with a consequent rise in its specific gravity The insensible loss averaged about 1,800 grams a day which is of some interest if we compare this patient with that of Table III In both instances a short operation with about the same amount of trauma was carried out Yet we find the insensible loss has increased 80 per cent in the instance of the patient with hyperthyroidism Due to increased heat production from the increased metabolism and the fever, greater quantities of water were used in the dissipation of heat by evaporation The day following operation there was a definite diminution in the insensible loss of water associated with an increase in body temperature This observation differs from the



behavior of the insensible loss in patients with fever due to infection. A complete discussion of this point involves the consideration of heat-regulating factors not pertinent to the subject of this paper and will be presented in another publication<sup>6</sup> on water exchange of patients with hyperthyroidism. The outstanding fact remains that the daily insensible loss of water of a patient with hyperthyroidism is high.

*Comment*—We have enumerated the fractions of water intake and output in health and presented observations on these facts in six surgical patients with varying kinds of lesions. We have tried to emphasize the importance of taking each of these water factors into account. Water leaves the body through the insensible loss from the skin and lungs, from the gastro-intestinal tract by vomiting, by diarrhoea and through fistulæ and as urine. It must be emphasized that the body will use its water to remove heat by evaporation from the skin in its attempt to maintain the body at a constant normal temperature at the expense of water going to the kidneys. In other words, the water of the insensible loss has preferential rights over the water of urine. Fluids lost from the gastrointestinal tract are absolute losses serving no physiological function. Therefore, with known positive losses, of at least two litres a day from the skin and lungs, a possible amount from the gastro-intestinal tract, one can compute the water needs for the next day by adding to these the estimated amount of urine required. This factor of two litres a day allowed for insensible loss is adequate for most cases and more than enough for the usual surgical case. We have shown<sup>1</sup> that the surgeon has some control over this loss. Patients placed in the old-fashioned ether bed lose about 300 cubic centimetres more from the skin and lungs during the recovery period from operation than do patients given lighter bed clothing. It is far easier to save water when possible than to lose it and replace it. We cannot see any more excuse for putting a patient after operation in a sweat bed than we can for the use of the old-time purge. Both procedures deprive the patient of water needlessly.

The kidney functions with the water available after other physiological processes have been provided for. In estimating the amount of urine desired, it is necessary to know the function of the kidney. If fluid is restricted, the urine arrives at a point where the greatest possible concentration of solids is carried. The normal individual excretes thirty-five to forty grams of solids per day and fifteen grams of water are required<sup>4</sup> to carry each gram of solids with the normal kidney working at maximum concentration. If the patient cannot get this amount of water, retention of waste products occurs. About 600 cubic centimetres of urine are then the minimal amount for the normal individual. In patients with kidney disease the kidneys cannot concentrate in a normal manner<sup>4 7 8 9</sup> and as high as forty grams of water may be necessary to carry away each gram of solids, in which instance about 1,600 cubic centimetres of urine would be necessary to prevent retention of solids. We feel that in every instance where the function of the kidneys is under question, a concentration test<sup>8 9</sup> should be done. Often, however, this cannot be carried out because of the acute nature of the disease or because of the undesirability of restricting fluids. Important information concerning the

kidneys can, however, be obtained by observing the specific gravity of the urine obtained from a patient who is dehydrated from disease or poor treatment. If the urine has a specific gravity of 1.030<sup>8</sup> the kidneys have a normal power of concentration. The first urine specimen after operation is also usually concentrated and here likewise the specific gravity will often give this same information. If the concentrating power of the kidney is normal or known, one can be certain of an adequate supply of available water if the specific gravity of the urine is definitely below the maximal concentrating power. We consider an adequate water intake to carry on the normal physiological activities of the body, one that provides for two litres of insensible loss, covers losses from the gastro-intestinal tract and furnishes at least 1,500 cubic centimetres of urine with a specific gravity of not more than 1.015.

In the condition of dehydration it must be remembered that when the body loses some of its own water it has also been deprived of some of its important minerals. Gamble and his associates<sup>10</sup> have emphasized the apparently important physiological requirement of the interstitial body fluid for a nearly stationary concentration of its substances. Water lost from the skin and lungs is accompanied by negligible amounts of inorganic salts compared to the amounts in interstitial body fluid. Therefore, this water loss would result in a concentration of inorganic salts in the interstitial fluid unless the excess is excreted through the kidney or water is added to the body. If intravenous methods are necessary, an isotonic glucose solution, 5 per cent, will supply the water, the glucose being rapidly oxidized. As is well known, fluids lost from the gastro-intestinal tract contain body fluid materials, chiefly sodium and chloride ion. Water alone will not restore body fluid volumes under this circumstance. The lost minerals must be replaced at the same time. Accordingly, for intravenous administration, physiological sodium chloride solution should then be given.

A word of caution may be given in regard to the intravenous use of highly concentrated solutions of glucose in dehydrated patients, since they abstract water from the body rather than restore it.

We do not infer that the usual surgical patient does not get enough fluids. Clinical experience has shown that patients usually do well with fluid intakes given on clinical indications alone. We do not believe that harm is done by the administration of larger amounts of fluid than are necessary to maintain water balance, but if excesses are given, it adds to the discomfort of the patient, and interferes with rest. The therapeutic use of water above the physiological requirements may have value but a discussion of this point is not in the province of this paper. By our analysis of the amounts of fluid lost from various sources, we offer a chance to compute and administer fluid in amounts approximating rather accurately the patient's physiological needs.

SUMMARY — (1) A study was made of six surgical patients over periods of several days to determine their increments of water exchange.

(2) A comparison of fluid ingested as such with the urine output does not give a true picture of water exchange.

(3) The insensible loss of the sick surgical patient varied in general from 1,800 cubic centimetres to 2,750 cubic centimetres with a rough average of two litres per day. This fluid has preferential right over water excreted through the kidney.

(4) The water requirements of the surgical patient can be determined by adding this constant factor of two litres to losses from the gastro-intestinal tract and then to an amount of fluid corresponding to the amount of urine considered necessary.

(5) If the concentrating power of the kidneys is known, the body will have an adequate supply of water if the specific gravity of the urine is definitely below the maximal concentration.

(6) It is considered that an adequate water intake is one that provides for a two-litre insensible loss, covers fluid losses from the gastro-intestinal tract, and furnishes 1,500 cubic centimetres of urine of a specific gravity of not more than 1.015.

(7) Water needs of the body can be calculated with an adequate degree of accuracy obviating the dangers of too small an intake and the discomforts of one too large.

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# ANNALS *of* SURGERY

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## SUBPHRENIC ABSCESS<sup>1</sup>

AN ANALYSIS OF 3,372 COLLECTED AND PERSONAL CASES

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OF THE late complications of intra-abdominal suppurative processes, subphrenic abscess is one of the most important. Infections of the subphrenic space occur much more frequently than is commonly supposed, but fortunately the majority of such infections will subside spontaneously and may never be diagnosed unless, because of the continuation of the septic manifestations, the possibility of the existence of the lesion is considered.<sup>1</sup> In our experience approximately only 30 per cent of subphrenic infections actually proceed to suppuration. It is possible that even more cases of subphrenic infection occur which are not diagnosed clinically, but of the cases of subphrenic infection which are diagnosed from the clinical manifestations only 30 per cent ultimately suppurate, the remaining 70 per cent subside spontaneously. Neuhof<sup>2</sup> observed among 972 cases of acute appendicitis fifteen cases of subphrenic infection (an incidence of 1.5 per cent). Similar observations have been made by Lee,<sup>3</sup> Clendening,<sup>4</sup> Ochsner,<sup>5</sup> and McNamee.<sup>6</sup>

The present report includes an analysis of 3,332 cases of subphrenic abscess collected from the world literature and a presentation of fifty additional cases treated in the Charity Hospital and the Touro Infirmary in New Orleans. Whereas a consideration of the racial incidence of subphrenic abscess is not available in the world literature, we have found that of thirty cases admitted to the Charity Hospital, where approximately half of all admissions are colored, fifteen occurred in the colored race. The remaining twenty cases were in Touro Infirmary and other private institutions to which Negroes are not admitted. In our series there were thirty-six (72 per cent) males and fourteen (28 per cent) females. The highest incidence in our series was in the fourth decade (32 per cent) and 70 per cent occurred between the ages of nine and forty, 6 per cent being between nine and twelve (Chart I).

Subphrenic abscess usually follows a suppurative process within the abdominal cavity. In the series of 3,322 collected cases of subphrenic abscess together with our own series of fifty cases the primary lesion was in the

\* Read before the American Surgical Association, May 10, 1933

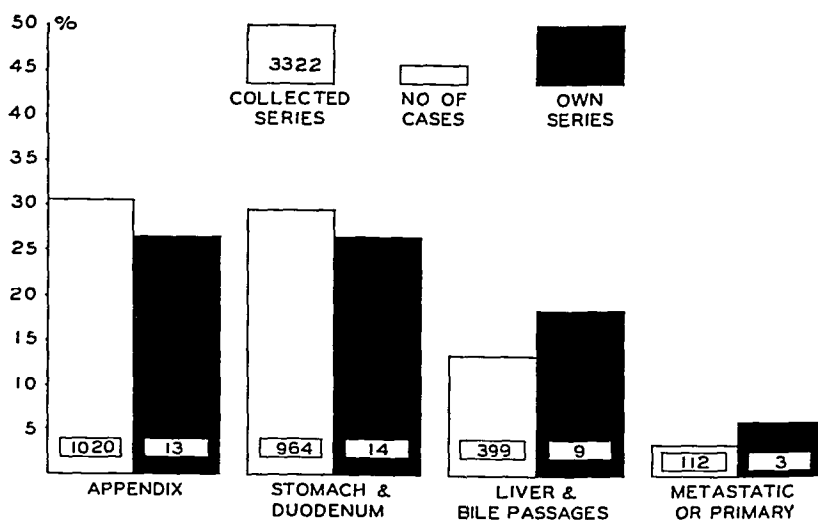
abdomen in 88 per cent of cases. Exceptionally infection of the subphrenic space may occur as a result of a blood-borne infection, the micro-organisms being transported from some distant focus. This was responsible for but 3.4 per cent of the collected cases and 6 per cent of our cases (Chart II). Still less frequently suppurative lesions in the thorax may extend through

*Incidence and Mortality Rates According to Decades*

	TOTAL NUMBER OF CASES	PERCENTAGE TOTAL GROUP	DIED	PERCENTAGE MORTALITY
9 - 19	10	20%	1	10%
20 - 29	9	18%	3	33%
30 - 39	16	32%	7	43.7%
40 - 49	8	16%	3	37.5%
50 - 59	4	8%	1	25%
60 - 69	3	6%	1	33.3%

CHART I—Table showing the incidence and mortality rate according to decades in the cases of the present series

the diaphragm into the subphrenic space. This occurred in 2.6 per cent of the collected series and 3.4 per cent of cases collected by Archibald<sup>7</sup>. In none of our own cases was the primary focus in the thorax. The most frequent causes of subphrenic abscesses are suppurative appendicitis and perforated lesions of the stomach and duodenum (Graph I). In the series of 3,322 cases of subphrenic abscess collected from the literature, 30.7 per



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GRAPH I—Graphic representation of the comparative frequency of the most frequent lesions in the collected and reported cases of subphrenic abscess

cent and 29 per cent, respectively, originated from appendicitis and a perforated lesion of the stomach or duodenum. Therefore, in approximately 60 per cent of all cases of subphrenic abscess the process originated from the appendix, stomach, or duodenum. In 12 per cent of the collected series

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the infection originated in the liver and bile passages (Chart II) Our own cases differ only slightly from the collected ones Of the fifty cases included in the present report, appendicitis, lesions of the stomach and duodenum, and liver and bile-passage infections were the cause of the subphrenic abscess in 26 i per cent, 28 per cent, and 18 per cent of the cases, respectively (Chart II)

In a collected series the incidence of subphrenic abscess complicating acute inflammations of the appendix varied from 0.34 per cent to 6.1 per cent, the average in 11,017 cases of acute appendicitis being 1.1 per cent (Chart III) The incidence is undoubtedly higher than these figures indi-

*Incidence of Subphrenic Abscess Following Acute Appendicitis as Determined by Cases Collected From the Literature*

AUTHOR	CASES ACUTE APPENDICITIS	NUMBER SUBPHRENIC ABSCESES	PER CENT ACUTE APPENDICITIS
VEGNI	368	5	1.3
ROSS	3391	31	0.7
ELSBERG	98	2	2
STILLMAN	545	9	1.65
BANCROFT	584	2	0.34
CUTLER	974	6	0.61
BRECKMAN	145	1	0.7
CLAIRMONT AND MEYER	1179	7	0.5
SUERMONDT	630	39	6.1
DEAVER	1700	12	0.7
WEBER	300	9	3.
DEWES	103	2	2
STEICHELE	<u>1000</u>	<u>5</u>	<u>0.5</u>
TOTAL	11017	130	1.1%

CHART III—The incidence of subphrenic abscess following acute appendicitis as determined by cases collected from the literature

cate, because in many cases the subdiaphragmatic complication is not even suspected, much less diagnosed Obviously in perforated appendicitis the incidence is higher Brown<sup>8</sup> observed two cases of subphrenic abscess among the 113 cases of perforated peptic ulcer operated upon at the Presbyterian Hospital in Philadelphia, an incidence of 1.7 per cent

The micro-organisms responsible for subphrenic infections vary according to the original infection The micro-organisms most frequently obtained from subphrenic abscesses are the colon bacillus, streptococcus, and staphylococcus *B. coli* were present in 25 per cent, 30.2 per cent, and 16 per cent, respectively, of Barnard's,<sup>9</sup> Whipple's,<sup>10</sup> and Beye's<sup>11</sup> cases The same authors found streptococci in 8.5 per cent, 20.9 per cent, and 54 per cent of their cases, respectively In our own series in which positive cultures were obtained, *B. coli* were present in 40 per cent, streptococci in 40 per cent, and staphylococci in 20 per cent

## SUBPHRENIC ABSCESS

Micro-organisms may gain entrance to the subphrenic spaces in a number of different ways. The infection may extend intraperitoneally, extraperitoneally, or through vascular channels from a neighboring or from a distant focus as follows:

(1) Obviously the simplest mode of infection is the local invasion of the subphrenic spaces by micro-organisms from lesions in the immediate vicinity.

(2) Peritoneal exudate from distant portions of the peritoneal cavity (right iliac fossa and pelvis) may drain into the subphrenic area. With the patient in the supine position the two lowest portions of the peritoneal cavity are the cul-de-sac of Douglas and the posterior portion of the subphrenic space, the general abdominal cavity being divided into these two areas by the ventral curvature of the lumbar spine. As suggested by Eisendrath<sup>12</sup> and Nather<sup>13</sup> the infection may extend from the right iliac fossa through the gutter between the ascending colon and the lateral parietal peritoneum to the region of the right kidney and thus gain entrance to the subphrenic space.

(3) Retroperitoneal phlegmon. As a result of infection of the retroperitoneal cellular tissue a phlegmon extending upward to the extraperitoneal subphrenic area may occur.

(4) Retroperitoneal lymphangitis. Infections may extend through the retroperitoneal lymphatics to the subphrenic spaces. This mode of infection has been especially emphasized by Munro.<sup>14</sup>

(5) Lymphangitis of lymph vessels accompanying the deep epigastric artery (Barnard<sup>15</sup>).

(6) Rupture of a liver abscess (usually following suppurative portal thrombophlebitis) into the subphrenic space.

Ullman and Levy<sup>16</sup> believe that it is possible to determine the route of infection from the location of the subphrenic abscess. Those infections which occur as a direct extension are located intraperitoneally, whereas those which follow infections of the cellular tissues are retroperitoneal, and those which extend by the lymphatic system are either intraperitoneal or retroperitoneal.

To Martinct,<sup>17</sup> in France, and Barnard,<sup>9</sup> in England, belongs credit for accurately describing the subphrenic spaces. Because so frequently infrahepatic and suprahepatic abscesses occur concomitantly, it is desirable to consider the subphrenic area as that space bounded above by the diaphragm and below by the transverse colon and transverse mesocolon (Fig. 1). The anatomy of this area which has been described in detail in previous publications<sup>9, 15, 16, 20</sup> is briefly as follows. The area between the diaphragm above and the transverse colon and transverse mesocolon below is roughly divided by the liver into suprahepatic and infrahepatic spaces which in turn are subdivided into right and left spaces. The suprahepatic area is divided into right and left portions by the coronary ligament, which is the reflection of the peritoneum from the undersurface of the diaphragm on to the superior surface of the liver and the falciform or suspensory ligament, the lower free edge of which extends to the umbilicus as the round ligament (Fig. 2). On the superior surface of the liver there are three intraperitoneal spaces and one extraperitoneal space, the extraperitoneal space being located, as the name implies,



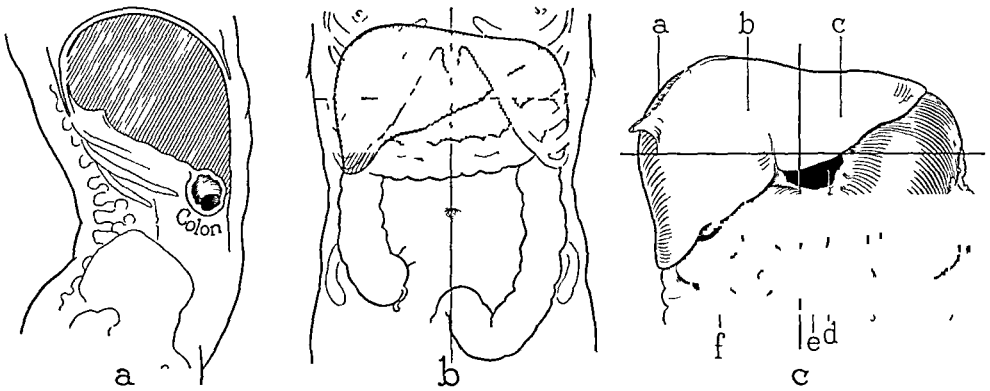


FIG 1—(a) The shaded area represents the subphrenic space bounded above by the diaphragm and below by the transverse colon and transverse mesocolon (b) Subphrenic space, shown in (a), is subdivided by the liver into suprahepatic and infrahepatic portions (c) Diagrammatic drawing showing the location of the various subphrenic spaces (a') Right posterior superior space located above the liver and behind the right lateral ligament which is the right prolongation of the coronary ligament (b') The right anterior superior space located above the liver and anterior to the right lateral ligament (c) The left superior space located between the liver and the left hemidiaphragm On the left, because the left lateral ligament courses posteriorly, there is only one space in contrast to the two spaces on the right (d') The left posterior inferior space or lesser sac located below the liver and behind the gastrohepatic omentum and stomach (e') The left anterior inferior space located below the liver on the left side and anterior to the stomach (f') The right inferior space located to the right of the round ligament and the ligament of the ductus venosus

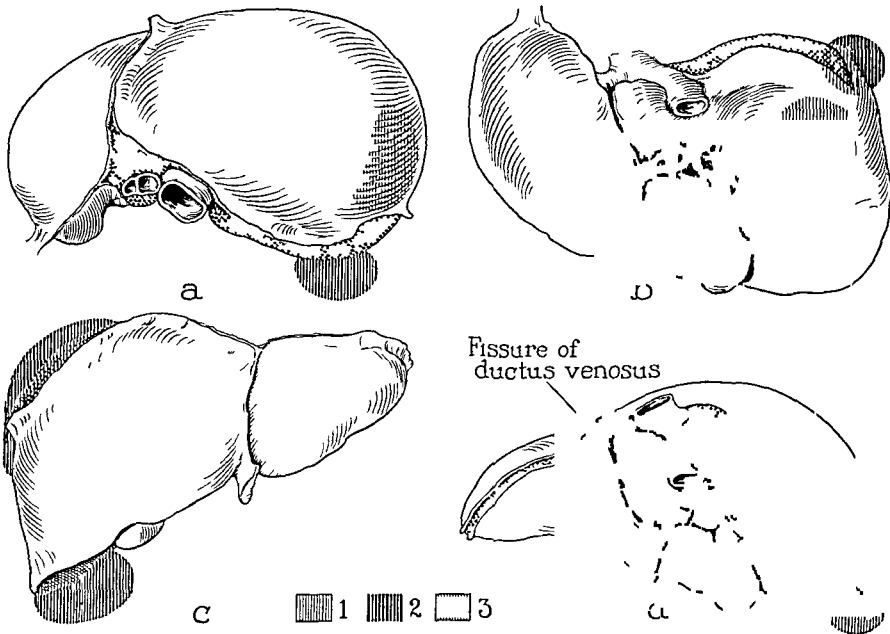


FIG 2—Diagrammatic drawing illustrating the most frequent locations for subphrenic abscesses viz in the right posterior superior and right inferior spaces (Key to figure—(1) Visible abscess areas (2) Abscesses invading peritoneal cavity (3) Invisible abscess areas) (a) Right inferior abscess is shown through the peritoneal cavity above the liver and behind the right lateral ligament (b) Liver viewed from below showing right inferior space abscess and abscess from right posterior superior space invading the peritoneal cavity (c) Liver viewed from in front showing right inferior space abscess below liver and the right posterior superior abscess above the liver and behind the right lateral ligament (d) Liver viewed from behind, showing typical location of right posterior superior space with abscess above the liver and behind the right lateral ligament

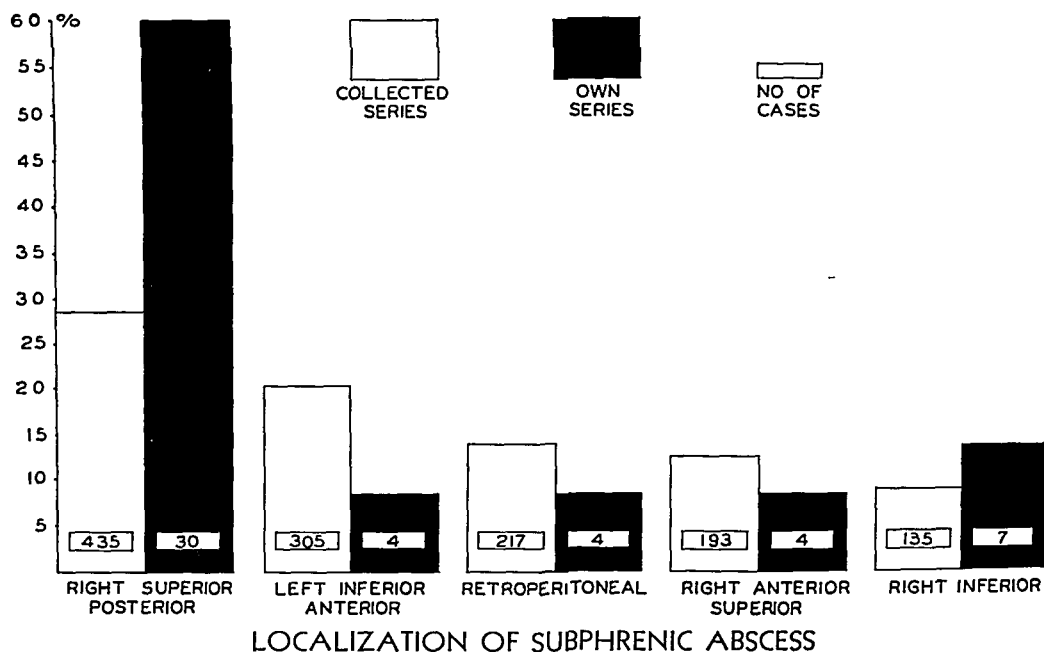
# SUBPHRENIC ABSCESS

## Location of Abscesses

	RT POSTERIOR SUPERIOR	RIGHT ANTERIOR	RT. ANTERIOR SUPERIOR	RETROPERITONEAL	LEFT ANTERIOR INFERIOR	LEFT POSTERIOR INFERIOR	LEFT SUPERIOR	CONTAINED	NOT DETERMINED
MARTINET	54 (41.63%)	4 (3.07%)		18 (13.84%)	38 (29.23%)	4 (3.07%)	47 (4.76%)	46 (4.66%)	12 (9.23%)
PIQUAND	272 (27.55%)	69 (6.96%)	141 (14.26%)	151 (15.30%)	211 (21.37%)	31 (3.14%)			19 (1.91%)
DEXTER	4 (66.67%)		1 (16.66%)	1 (16.66%)					
GATEWOOD									9 Left (45.55%) and 32 Right (54.45%)
FIFIELD AND LOVE	29 (25.89%)	29 (25.89%)	13 (11.60%)	20 (17.85%)	14 (12.5%)	7 (6.25%)			
SCHWARTZ	5 (56.55%)	1 (11.11%)	1 (11.11%)		1 (11.11%)			1 (11.11%)	
BARNARD	10 (10.75%)		27 (29.03%)	23 (24.73%)	30 (32.36%)	3 (3.23%)			
PANCAST	8 (50%)		1 (6.25%)	4 (25%)	2 (12.50%)			1 (6.25%)	
DOHERTY AND ROWLANDS	3 (42.86%)	1 (14.28%)	1 (14.28%)		1 (14.28%)			1 (14.28%)	
DOUGLAS	5 (62.50%)	3 (37.50%)							
MONABLE	3 (33.33%)	3 (33.33%)			1 (11.11%)			2 (22.22%)	
EISENDRATH	3 (33.33%)	4 (44.44%)			1 (11.11%)			1 (11.11%)	
OGHSNER	19 (82.61%)	4 (17.39%)							
ANDRO	3 (37.5%)	2 (25%)			2 (25%)	1 (12.5%)			
ROSS	13 (40.63%)	14 (43.75%)			1 (3.12%)			2 (6.25%)	2 (6.25%)
MATHER	4 (19.05%)	1 (4.76%)	8 (38.09%)		3 (14.29%)	1 (4.76%)			
TOTAL	435 (28.86%)	135 (8.9%)	153 (10.1%)	217 (14.4%)	305 (20.2%)	47 (3.1%)	55 (3.6%)	4 (1.9%)	72 (4.7%)
OGHSNER AND GRAVES	30 (60%)	7 (13.5%)	4 (8%)		4 (8%)		1 (2%)	4 (8%)	
GRAND TOTAL	464	142	197	221	309	47	56	56	72

CHART IV—Location of subphrenic abscesses in 1,517 collected cases and fifty cases included in the present report

extraperitoneally within the confines of the coronary ligament. On the right side the right lateral ligament, which is the right prolongation of the coronary ligament, divides the area into two spaces, a large anterior one and a relatively small posterior one, being, respectively, the right anterior superior and the right posterior superior spaces. The left lateral ligament coursing along the posterior border of the left lobe of the liver separates the superior surface from the inferior surface of the liver. In the left suprahepatic area there is only one space, the left superior. In the infrahepatic area there are three intraperitoneal spaces which are divided into right and left portions by the round ligament and the ligament of the ductus venosus. To the right of these structures is large space known as the right inferior space. To the left are two spaces separated from each other by the stomach and the gastrohepatic omentum, the anterior one being the left anterior inferior space and the posterior one being the left posterior inferior space or lesser peritoneal sac. The space most frequently involved in subphrenic infections is the right posterior superior space, probably because the most frequent cause of subphrenic infection is suppurative appendicitis. The right posterior



GRAPH II—Graphic representation of the most frequent sites of localization of subphrenic abscesses in the collected and reported cases

superior space is the earliest involved because the inflammatory exudate travels upward from the right iliac fossa along the paracolic groove. In a series of 1,517 cases collected from the literature in which localization of the abscesses was stated, the right posterior superior space was involved in 28.8 per cent. In our own series of fifty cases this space was involved in thirty (60 per cent) (Chart IV). In addition to abscesses in the above-described subphrenic spaces, retroperitoneal abscesses may dissect upward between the diaphragm and diaphragmatic peritoneum and thus become retroperitoneal subphrenic abscesses. In the collected series, abscesses in the retroperitoneal spaces (14.4 per cent) followed the right posterior superior space infections in frequency, whereas in our series the right inferior space was involved in 13.5 per cent of the cases (Graph II). In four (8 per cent) of our fifty cases, abscesses were found in both the right posterior superior and the right inferior spaces. Similar association of infection of these two spaces has been observed by Nather and Ochsner,<sup>18</sup> Strauss,<sup>21</sup> and Milloy.<sup>22</sup> Intraperitoneal subphrenic abscesses occur more frequently than the extraperitoneal. In Elsberg's<sup>23</sup> series of seventy-three cases the lesion was extraperitoneal in 27 per cent, intraperitoneal in 48 per cent, and doubtful in 25 per cent of the cases.

## SUBPHRENIC ABSCESS

The clinical picture in subphrenic abscess in general is one of continued infection. If a patient who has had an antecedent suppurative intraperitoneal process fails to improve as he normally should and in whom no other focus can be demonstrated to account for the septic manifestations, one must consider subphrenic infection as a possible cause until proved otherwise. Only by keeping the condition in mind and looking for other diagnostic evidences of this suppurative process which is located in such an inaccessible portion of the peritoneal cavity can an early diagnosis be made. Undoubtedly the inaccessibility of the subphrenic region is responsible for the delay in diagnosis in many cases. The fact that subphrenic infections may exist for long periods of time and produce few or no characteristic manifestations and not be recognized is exemplified by the following. Russel<sup>21</sup> reports three cases of subphrenic abscess in which diagnoses were made seven months after perforation of a peptic ulcer, one year after pneumonia, and seven years after an empyæma. Lockwood<sup>25</sup> reports a case in which the diagnosis was not made until twenty months after the original operation, and Grove<sup>26</sup> reports two cases in which the diagnoses were made one and a half years and three and a quarter years, respectively, after the original intraperitoneal suppuration. Barnard<sup>9</sup> and Whipple<sup>10</sup> suggest that the onset of symptoms in cases of subphrenic abscess is usually one of three types as follows:

(1) Sudden abrupt onset with symptoms simulating an acute intra-abdominal suppuration. These are usually cases in which the causative agent, such as perforated peptic ulcer, perforated appendicitis, *etc.*, results in massive contamination of the peritoneal cavity. Thirty-four and three-tenths per cent of Whipple's<sup>10</sup> and 62.6 per cent of Barnard's 9 cases were of this type.

(2) Insidious onset usually following an obscure intra-abdominal lesion. These cases are frequently not suspected and, therefore, not diagnosed. In 40.6 per cent of Whipple's<sup>10</sup> cases the onset was of this type.

(3) Following laparotomy for an intraperitoneal suppurative process, at which time the subphrenic space was uninvolved, the septic manifestations continue and the patient does not improve. Forty-seven and three-tenths per cent of Barnard's 9 cases were of the last two types and 25 per cent of Whipple's<sup>10</sup> cases were of the third type.

In our experience most cases have followed a known intraperitoneal suppuration. Of the fifty cases herein reported, the onset was sudden in eight (16 per cent), insidious in seven (14 per cent), whereas in thirty-five (70 per cent) cases systemic manifestations continued following drainage of the original suppurative process. In this last group, even though the original suppurative lesion had been treated correctly, systemic manifestations of infection persisted. Pyrexia and leucocytosis continued, and the patients exhibited other signs of continued infection. In addition to these systemic signs there may or may not be localizing manifestations. Occasionally there will be a sense of pressure in the upper abdomen or loin, and difficulty in breathing, especially on deep inspiration, may be complained of. In those

individuals with an infection of the right posterior superior space, the pain, when present, is referred to the lumbar region, whereas in those cases with right anterior superior space or right inferior space infections the pain is referred to the right costal margin. Limitation of respiratory movements on the affected side occurs relatively early. The diaphragm is elevated and its excursion diminished. Of greatest diagnostic importance is persistent, localized tenderness over the involved portion. If the abscess is in the right posterior superior space, there is persistent, localized tenderness over the right twelfth rib, which may be the only sign. The tenderness is localized along the costal margin, on their respective sides, in right anterior superior space, right inferior space, left superior space, and left anterior inferior space abscesses. If the tenderness persists together with continued systemic manifestations of unabating infection, one is justified in diagnosing a subphrenic infection of the particular space involved, and if, under conservative therapy, the symptoms and signs do not subside, an exploration of the space is justified. In right anterior superior space, right posterior superior space, and left superior space abscesses the liver is displaced downward and can be felt extending for varying distances below the costal margin. The area of liver dullness is definitely increased.

The roentgenological findings are of diagnostic importance. Elevation and immobility of the diaphragm have been especially emphasized by Lewald,<sup>27</sup> Pancoast,<sup>28</sup> Granger,<sup>29</sup> O'Brien,<sup>30</sup> Schwartz,<sup>31</sup> and McNamee.<sup>6</sup> In our series roentgenograms were obtained in forty. In thirty-three (80 per cent) there was an elevation of the diaphragm. Pancoast<sup>28</sup> and Granger<sup>29</sup> stress the fact that even though roentgenological findings are of utmost importance as regards diagnosis of subphrenic infection, it is important and essential to correlate these findings with the clinical data in order that the correct diagnosis might be made. Roentgenograms should be made with the patient in the upright position and, as suggested by Granger,<sup>29</sup> preferably at a distance of six feet. Two views, an anterior posterior and a lateral one, should always be obtained. Granger<sup>29</sup> differentiates between subphrenic abscesses resulting from perforation of a liver abscess and those in which infection occurs as a result of a suppurative process within the peritoneal cavity as follows. Roentgenograms of subphrenic abscesses following rupture of a liver abscess show obliteration of the cardiophrenic angle in the postero-anterior view and obliteration of the anterior costophrenic angle in lateral view, whereas roentgenograms of subphrenic abscesses following intraperitoneal infections show obliteration of the costophrenic (instead of the cardiophrenic) angle in the anteroposterior view, and an obliteration of the posterior (instead of the anterior) costophrenic angle in the lateral view. This is possibly due to the fact that the most frequently involved space following an intra-abdominal suppurative process is the right posterior superior one. As the presence of gas in subphrenic abscesses represents a late finding, its absence does not in any way eliminate a diagnosis of subdiaphragmatic suppuration. Unfortunately, in text-books and many other publications the importance of roentgenological demonstration of gas with the production of a typical fluid

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level has been emphasized. When gas is present, it is, of course, of diagnostic importance, but as in the majority of cases gas is not present and in practically all represents a late finding, its absence is of little significance. According to Elsberg<sup>21</sup> and Berman,<sup>32</sup> only 15 per cent of subphrenic abscesses contain gas. Gas is more apt to be demonstrated in those cases in which the antecedent lesion was a perforated peptic ulcer or perforation of some other portion of the gastro-intestinal tract. Its presence may be accounted for in this way or may result from the production of gas by gas-producing micro-organisms. In those cases in which gas is present in the abscess Whipple,<sup>10</sup> Sommer,<sup>33</sup> and Meller<sup>34</sup> advocate taking roentgenograms in various positions in order to show the extent of and more accurately localize the abscess. By so doing Sauer<sup>35</sup> was able to diagnose three separate abscess cavities in a patient of his.

The attempted aspiration of pus from a subphrenic abscess is to be condemned, because of the danger of contaminating uninvolved portions of the pleural or peritoneal cavities. Barnard<sup>9</sup> reported a case in which, following the transpleural aspiration of a subphrenic abscess, the patient collapsed and died three hours later. At autopsy one and a half pints of pus were found to have leaked into the pleural cavity and this undoubtedly was the cause of the patient's death. The following are opposed to aspiration of these abscesses: Whipple,<sup>10</sup> Ochsner,<sup>5, 19, 20</sup> Graf,<sup>36</sup> Grove,<sup>37</sup> Schwartz,<sup>31</sup> and Doherty and Rowlands.<sup>38</sup> Even those surgeons who advocate aspiration of the subphrenic area in order to attempt to determine the presence of pus emphasize that such a procedure should be done directly before operation so that if pus is found, immediate incision and drainage might be instituted. We are convinced from our own personal experience and also based upon sound surgical principles that if aspiration of the subphrenic space is to be attempted it should be made in such a way that uninvolved portions of the pleura and peritoneum are not traversed with the aspirating needle. This can be accomplished, especially in infections of the right posterior superior space, by introducing the needle below the twelfth rib and extending upward and forward. It is important when this is done to have the syringe attached to the needle and to maintain aspiration during the introduction of the needle. Only in this way can one be relatively certain of not traversing an encapsulated suppurative process and penetrating beyond it. Occasionally such will occur even though one aspirates during the introduction of the needle due to the plugging of the needle with thick exudate. We, however, believe it is distinctly safer and, therefore, much better to explore the subphrenic space under local analgesia as only in this way can one be certain that contamination of one of the serous cavities does not occur.

Intrathoracic inflammatory processes are the most frequent complications of subphrenic abscess and when present usually mask the clinical picture. The incidence of intrathoracic complications varies according to different authors and undoubtedly varies with the length of time which elapses between the development of the subphrenic infection and the institution of therapy. The majority of clinicians are of the opinion that subphrenic

Complications

PERFORATIONS	PLEURISY	MAY-LIA	BRONCHO- PLEURAL PISTULA	PERICARDITIS	MEDIASTINAL ABSCESS	GENERAL PERITO- NITIS	PERFORATION INTO INTESTINE	PERFORATION TO OUTSIDE	PNEUMONIA	PNEUMOTHORAX	LUNG ABSCESS
FERNICY	12 (65 72%)							2 (14 28%)			
BEYE	2 (9 09%)	10 (45 45%)	6 (27 47%)						(10 28%)		
LANG	67 (60 72%)			16 (19 28%)							3 (16 7%)
LOCFWOOD	4 (22 22%)	11 (61 11%)									
MARTINET	33 (100%)										
PIQUAND	176 (25 56%)	81 (11 84%)	112 (16 37%)	41 (5 99%)	2 (2 90%)	16 (2 32%)	34 (4 97%)	24 (3 51%)			
FINTELSTEIN	74 (41 57%)	46 (25 28%)	46 (25 28%)	13 (7 30%)							
DEXTER	3 (60%)	1 (20%)	1 (20%)								
GATEWOOD	1 (5 85%)	11 (64 10%)				1 (5 85%)			1 (5 85%)		1 (5 85%)
PIFIELD AND LOVE	5 (33 33%)	4 (26 66%)					4 (26 66%)				2 (13 3%)
WHIPPLE	4 (19 04%)	10 (47 61%)							7 (33 33%)		
PESUTZ	60 (100%)										
CRUNEISEN	40 (97 85%)					1 (2 43%)					
YCHW RTZ		4 (80%)	1 (20%)								
BARNARD	6 (20 69%)	5 (17 24%)	4 (13 79%)			1 (3 45%)	11 (37 93%)	2 (6 89%)			
PANCOAST		1 (100%)									
DOHERTY AND ROWLANDS		3 (75%)							1 (25%)		
ELSEBERG	8 (21 05%)	22 (57 89%)	6 (15 75%)						1 (2 63%)		1 (2 63%)
DOUGLAS		2 (66 66%)	1 (33 33%)								
McNAMEE	1 (16 66%)		1 (16 66%)				1 (16 66%)		1 (16 66%)		2 (33 3%)
EISENDRATH		4 (100%)									
KUNTO		2 (66 66%)					1 (33 33%)				
NATHER	3 (50%)	1 (16 66%)									2 (33 3%)
ROSS	3 (25%)	6 (50%)	2 (16 66%)						1 (8 33%)		
TOTAL (COLLECTED)	371 (29 1)	224 (17 5%)	134 (10 4%)	70 (5 3')	2 (0 2%)	19 (1 4)	51 (3 8%)	28 (2 3%)	15 (0 9%)	1 (0 1%)	11 = 1302 (0 6%)
OCHSNER AND GRAVES	5 (25%)	8 (40%)	1 (5%)						4 (20%)	2 (10%)	20
GRAND TOTAL	381	232	135	70	2	19	51	28	19	3	11 = 1322

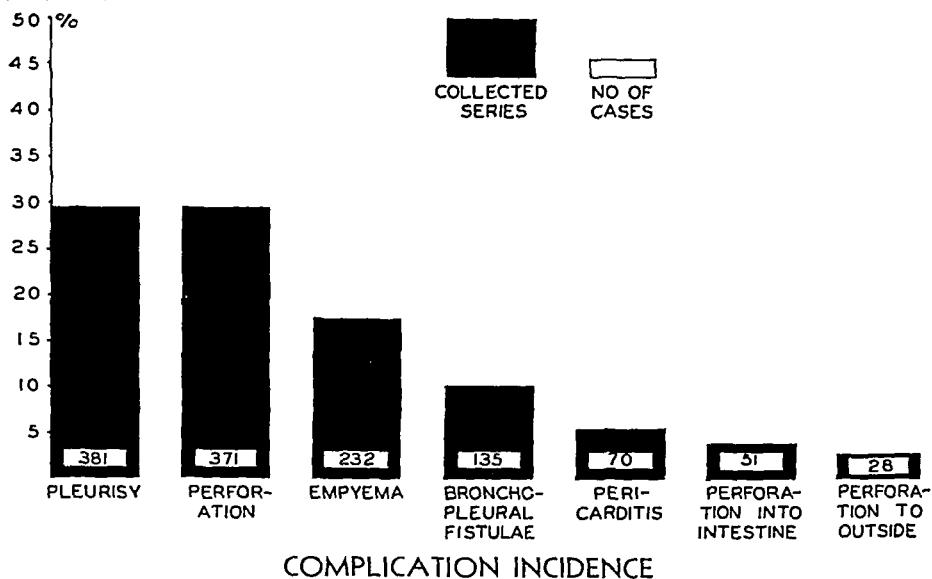
CHART V —Complications and incidence in collected and reported cases of subphrenic abscess

infections are frequently complicated by extension to the thorax. According to Clute<sup>39</sup> and Beye,<sup>11</sup> the thoracic involvement usually consists of an irritative pleuritis which results in a serious effusion. We cannot agree with Beye<sup>11</sup> that one of the earliest findings in subphrenic abscess is pleural effusion or with Clute<sup>39</sup> that "it is almost always true that a simple serious pleurisy will be present in the chest when there is pus just beneath the diaphragm". Conversely, we believe that extension of the infection to the thorax usually is the result of a late diagnosis of the subphrenic infection which has existed long enough for the micro-organisms and toxins to have passed through the diaphragmatic lymphatics into the pleural cavity. We are convinced that if an early diagnosis of subphrenic abscess is made and the correct therapy instituted the incidence of intrathoracic complications can be materially reduced. We agree with Dexter<sup>40</sup> that "obviously it is highly desirable to drain the abscess before the structures above the diaphragm are involved". That subphrenic abscesses can be diagnosed before intrathoracic complications occur is shown by the fact that in the personally treated cases none of these complications occurred. Of thirty-one cases of subphrenic infection reported by Beye,<sup>11</sup> thoracic complications occurred in twenty-three (74 per cent). Beye's<sup>11</sup> statistics suggest, however, that the diagnoses in his cases were made relatively late because of the twenty-three cases with thoracic complications, fifteen (65 per cent) had a gross perforation of the diaphragm. In Lockwood's<sup>27</sup> eighty-two cases of subphrenic abscess operated upon at The Mayo Clinic intrathoracic complications occurred in 20.7 per cent. In addition to simple serious effusion which may be of little or no consequence as regards the subsequent clinical course, but which may be of great importance as regards the difficulty in diagnosing the condition, there may be other intrathoracic complications such as bronchopleural fistula, lung abscess, and pneumonitis (Chart V Graph III). The manner in which pneumonitis and infections of the pulmonary parenchyma might occur without involvement of the pleura is suggested by Menville's<sup>41</sup> and Schlanger's<sup>42</sup> observations. Menville was able to demonstrate in both animals and humans that following the intraperitoneal injection of thorium dioxide, extension to the bronchial and retrosternal lymph nodes occurred. Schlanger<sup>42</sup> found that roentgenograms taken following the filling of a subphrenic abscess cavity with lipiodol showed lymphatic channels extending retroperitoneally and retropleurally to the hilum of the lung.

The prognosis in subphrenic abscess is dependent upon a number of factors, chief among which are the length of time elapsed from the beginning of the infection to the institution of therapy, the presence of complications, and the treatment instituted. Everything else being equal, the earlier the recognition of a subphrenic abscess and the earlier correct drainage is instituted, the better is the prognosis. As a result of delayed diagnosis the patient may die of sepsis. The importance of thoracic complications as regards prognosis is exemplified by the following statistics. Of the thirty-



one deaths in Lockwood's<sup>25</sup> series, thirteen (41.9 per cent) had intrathoracic complications. The mortality rate in Beye's<sup>11</sup> cases with thoracic complications was 43.5 per cent, whereas the mortality rate in the cases with no complicating thoracic lesion was 25 per cent. Of the seven cases which developed empyæma in Gatewood's<sup>43</sup> series, five died. In our own series the mortality rate in those cases with thoracic complications was 52 per cent, whereas in those with no thoracic complications the mortality rate was 18 per cent. The mortality rates in the Charity Hospital series and in the private cases in our series were approximately equal, 32.2 per cent in the former and 31.5 per cent in the latter. The race and sex were of no prognostic importance, the mortality rates being equal in the white and colored races and in both sexes. The mortality rate was highest in the fourth decade (43.7 per cent) and lowest in the second decade (10 per cent) (Graph IV Chart I).



GRAPH III—Complications and incidence in order of their frequency in the collected cases of subphrenic abscess

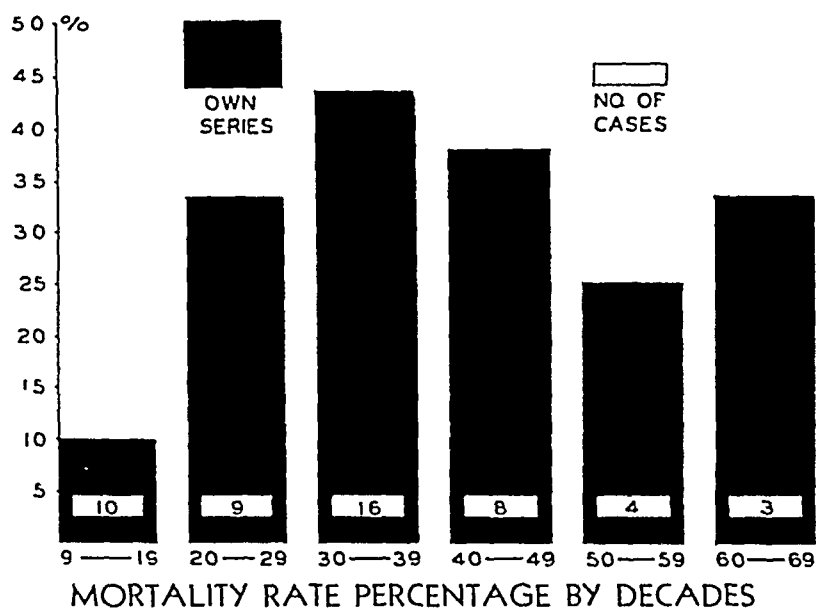
Whereas non-operative conservative treatment is indicated in cases of subphrenic infections which have not progressed to suppuration, the treatment of a subphrenic suppurative process is incision and drainage. Of 1,072 reported cases of subphrenic abscess in which non-operative treatment was used, the mortality rate was 91.1 per cent as contrasted with the mortality rate of 33.6 per cent in 1,693 cases in which drainage was instituted. All the cases in our series were operated upon with a general mortality rate of 32 per cent (Chart VI Graph V).

The prognosis in subphrenic abscess depends not only upon the institution of drainage but also upon the type of drainage employed. If in draining the abscess a contamination of an uninvolved serous cavity occurs, obviously the prognosis is much worse both as regards life and subsequent morbidity than it would be if such a contamination did not occur. In the collected series of 189 cases of subphrenic abscess drained without contamination of the pleural or the peritoneal cavities, the mortality rate was 21 per

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cent, whereas of 305 cases drained transpleurally 39 per cent died, and of 307 drained transperitoneally 35.5 per cent died. In our own series the mortality rates following extraperitoneal, transpleural, and transperitoneal drainages were 13.6 per cent, 50 per cent, and 41.6 per cent, respectively (Chart VI Graph V)

*Treatment*—The treatment of subphrenic abscess is entirely surgical and as in most pyogenic suppurative processes the treatment consists of incision and drainage. It must, however, be emphasized that the majority of subphrenic infections do not progress to suppuration and that in those cases in which a subphrenic infection is diagnosed before suppuration has occurred, conservative treatment should be instituted and continued until either suppuration has occurred or spontaneous resolution has taken place. This can usually be easily determined by the clinical course. The necessity for surgi-



GRAPH IV—The mortality rate percentages by decades in the cases of subphrenic abscesses reported in the present communication

cal drainage in cases of subphrenic suppuration is emphasized by the mortality statistics quoted above. As already mentioned, the mere drainage of a subphrenic suppurative process, however, is not sufficient in order to treat the patient properly. Here, as elsewhere, it is of utmost importance to avoid unnecessary contamination of uninvolved areas. Of especial importance is the avoidance of contamination of an uninvolved serous cavity as it is a well-known fact that the flooding of a virgin serous cavity with toxic material, because of the marked absorbability of serous membranes, is apt to produce systemic symptoms and even death of the individual. Everything else being equal, it is imperative, therefore, to drain a subphrenic suppurative process in such a way that uninvolved portions of either the pleural or peritoneal cavity are not contaminated. This fact should be emphasized because even at the present time this surgical principle has been more or less disregarded in the treatment of these suppurative processes. Barnard,<sup>9</sup> in 1908, considered that of thirty-six deaths from subphrenic abscess reported by him twenty-four were avoidable. In regard to this he states "In

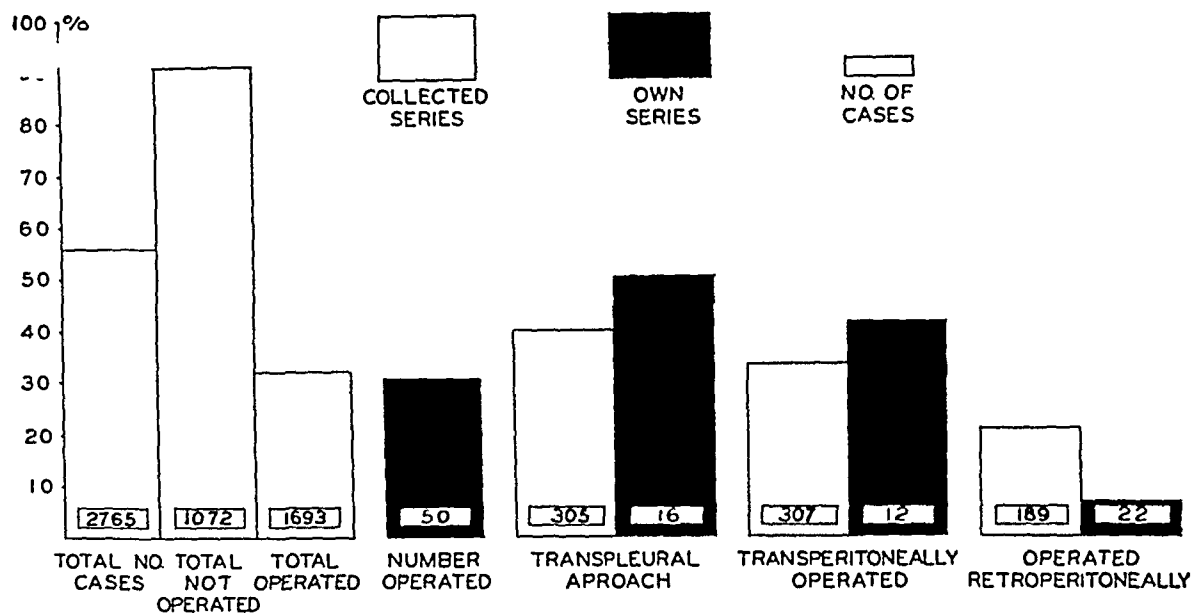
## Mortality Rate Percentages

	TRANSPERITONEAL		TRANSPLURAL		RETROPERITONEAL		TOTAL GROUP		OPERATED		NON-OPERATED							
	Total	Died	Total	Died	Total	Died	Total	Died	Total	Died	Total	Died						
WIFFIELD AND LOVE	21	5	23 8%	32	14	43 7%	6	1	16 7%	78	39	50%	59	20	32%	19	19	100%
FLYNN																		
DOUGLAS	2	0	0	3	1	33%	38	7	18 4%	313	94	30%	313	94	30%			0
GAGATE OOD																		
DOHERTY AND RO LANDS																		
DEXTER																		
BARWARD	39	15	38%	16	6	37 5%	18	6	33 3%	76	36	47%	64	24	37 5%	12	12	100%
BERLAN	1	0	0															
TUFT	2	0	0	1	1	100%	1	0	0	2	0	0	2	0	0			
LOGWOOD																		
MICHEL AND GROSS																		
SCHWARTZ																		
PERUTZ																		
MADYL																		
GUEREISEN																		
YUNRO	3	1	33%	1	1	100%												
ROSS	12	5	41%	6	5	83%	2	0	0	33	23	70%	20	10	50%	13	13	100%
EISENDRATH																		
MCHALE	3	0	0	5	2	40%	1	0	0	34	11	32 6%	33	10	30 3%	1	1	100%
PANCOAST																		
PANCOAST	3	0	0	5	2	40%	1	0	0	15	5	33%	13	4	30%	2	1	50%
ELSBURG	1	1	100%															
ELSBURG																		
OCHSNER																		
OCHSNER																		
BROTH																		
PIQUAND	219	81	37%	206	70	34%	52	13	25%	19	1	5 25%	19	1	5 25%			
PIQUAND																		
LOVELSTEIN																		
LANC																		
FITTELSTEIN																		
LARTINET																		
NATHER																		
TOTAL (COLLECTED)	307	110	35 5%	305	119	39%	189	40	21 17%	2765	1546	56%	1693	569	33 6%	1072	971	91 14%
OCHSNER AND GRAVES	12	5	41 6%	16	8	50%	22	3	13 6%	50	15	32%	50	15	32%			

CHART VI—Mortality rate in 2796 collected cases and fifty cases included in the present report according to the type of therapy whether operative non operative and if operative according to the type of operation used

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short, half the avoidable deaths may be attributable to the fact that the condition was not recognized at all, the other half to the absence of exact and detailed knowledge of the localization and character of subphrenic abscesses on the part of the surgeons when they were planning or executing their operations." The high mortality rate following operations of subphrenic abscess is still undoubtedly due to the conditions which were suggested by Barnard," in 1908. Because suprahepatic abscesses, even though they are located within the abdomen, are covered by the thoracic cage and because the most direct route to these abscesses is through the thoracic cage, transthoracic drainage has been considered the method of choice by most surgeons. The method employed in draining a subphrenic abscess, of course, depends largely upon the location of the abscess. Everything else being equal, drainage by the most direct route without contamination of a serous cavity will give the best results. The operations for subphrenic abscess may



### MORTALITY RATE PERCENTAGES

GRAPH V—Graphic representation of results obtained in collected and reported cases of subphrenic abscess, both operatively and non operatively. At the right the results obtained by the various methods of approach in the collected and herein reported cases are graphically compared.

be divided into two large groups, *i.e.*, transthoracic and transabdominal. These, in turn, may be divided into transerous and extraserous approaches. A transthoracic extraserous approach is accomplished either by incising below the reflection of the pleura or by mobilization of the costophrenic angle of the pleura upward. The transabdominal extraserous approach is accomplished by incising over the abscess in extraperitoneal abscesses or by mobilizing the parietal peritoneum from the undersurface of the diaphragm until the abscess cavity is reached in suprahepatic infections. Similarly, intraperitoneal abscesses in which adhesions are present between the parietal peritoneum and abscess cavity can be drained to all intents and purposes extraserously, because if the incision is made through the area of adhesions no contamination of the uninvolved peritoneum will occur.

The transpleural method of drainage is too frequently employed. In the transpleural drainage an attempt is made to prevent contamination of

the pleural cavity by suturing the costal and diaphragmatic layers of pleura together, a procedure which was first suggested by Trendelenburg,<sup>44</sup> in 1883. That this procedure does not always protect the virgin pleural cavity against invasion is exemplified by Gatewood's<sup>43</sup> and our own statistics. In the only two of our cases (Cases XI and XX) in which suture of the costal and phrenic layers of the pleura were recorded at the time of operation, a fatal empyæma resulted. The results obtained in the collected series of subphrenic abscesses and in our own series demonstrate the danger of transpleural drainage. Of 305 collected cases drained transpleurally, 39.0 per cent died. Sixteen of our own cases were drained transpleurally with a mortality rate of 50 per cent (Chart VI). Of the sixteen drained transpleurally, the free pleural cavity was opened seven times with a fatal outcome in six (85 per cent). Of the nine in which the free pleural cavity was recorded as not being opened, only two (22 per cent) terminated fatally. Boeckel,<sup>45</sup> in 1889, suggested that transthoracic drainage could be safely performed in cases of subphrenic abscess without danger of injury to the pleura, because as a result of elevation of the diaphragm the costophrenic angle would be elevated above the line of incision. This conception is shared by many surgeons today and is undoubtedly one of the reasons why the transpleural operation is considered a safe one. However, Melnikoff<sup>46 47</sup> has shown by his anatomical investigations that because of the fixation of the costophrenic reflection of the pleura to the ribs it is impossible for this portion of the pleura to become elevated, even though the elevation of the diaphragm may be extreme. One is not justified in assuming, therefore, that the danger of injuring the pleura is slight as a result of transthoracic drainage in those cases in which there is an elevation of the diaphragm. Melnikoff<sup>46 47</sup> is of the opinion that in many of the cases in which it is thought that obliteration of the costophrenic angle has occurred as a result of adhesions the incision is actually made below the reflection of the pleura and, therefore, injury and contamination of the pleural cavity do not occur. Transthoracic extrapleural drainage may be accomplished, as suggested by Parijsky<sup>48</sup> by mobilization of the costophrenic angle upward. This procedure has been successfully employed by Melnikoff,<sup>46 47</sup> Whipple,<sup>10</sup> and Elkin.<sup>49</sup> Brown<sup>8</sup> objects to this method, however, because he has found it difficult to mobilize the pleura due to its firm adherence to the diaphragm and chest-wall as a result of inflammatory reaction.

Similarly, transperitoneal drainage that permits contamination of uninvolved portions of the peritoneum is objectionable. Obviously, no such drainage should be attempted as illustrated by the reported statistics and also our own. In 307 collected cases in which transperitoneal drainage was used, but in many of which an uninvolved portion of peritoneal cavity was probably not traversed because of limiting adhesions, the combined mortality rate was 35.5 per cent. In our own cases twelve were drained transperitoneally with a mortality rate of 41.6 per cent. Of the eight which were drained through limiting adhesions and, therefore, without contaminating

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uninvolved peritoneum, only one (12.5 per cent) died. All the remaining four drained across uninvolved peritoneum died (100 per cent). (Chart VII Graph V)

Ideally, therefore, drainage of subphrenic abscesses should consist of adequate evacuation of the abscess in such a way that contamination of the pleural and peritoneal cavities does not occur. We believe that this can be accomplished best by some type of extraperitoneal drainage, approaching the abscess cavity either from behind or from the front, according to the location of the abscess. In those cases in which the abscess is located in the right posterior superior space, which is the most frequent site involved both in the collected series (29 per cent) and in our own series (60 per cent) the "retroperitoneal operation" offers an ideal method of approach. It has the advantage that abscesses in the right posterior superior space and the frequently associated abscess in the right inferior space may be drained simultaneously through the same incision. It also has the distinct advantage that neither uninvolved portions of the pleural nor the peritoneal cavities are traversed or contaminated by the procedure. The technic of the "retroperitoneal operation" is as follows. Under paravertebral block analgesia and with the patient lying on the unaffected side on either a kidney rest or sandbag placed in the lumbar region so that a scoliosis of the lower dorsal and lumbar spine is produced, an incision is made over and parallel to the twelfth rib (Fig 3). The entire twelfth rib is resected subperiosteally, care being taken not to injure the pleura which may be immediately beneath the rib (Fig 4). The erector spinae mass of muscles is retracted medially and a transverse incision is made at right angles to the spine across the bed of the resected rib at the level of the spinous process of the first lumbar vertebra (Fig 5). It is extremely important that this incision through the bed of the rib be made transversely at this level and not parallel to the rib, because only in this way can one be sure that the costophrenic angle of the pleura will not be injured. Melnikoff<sup>47</sup> has shown that in 92 per cent of the cadavers examined by him the costophrenic angle of the pleura on the right side either completely covered or touched the twelfth rib somewhere in its course. In 62 per cent of his observations the pleura extended below the right twelfth rib. He further showed, however, that even though the relation of the costophrenic angle to the twelfth rib may vary considerably in different individuals, in no instance does the costophrenic angle extend as far caudally as the level of the spinous process of the first lumbar vertebra. Therefore, a transverse incision at the level of the spinous process of the first lumbar vertebra will invariably miss the pleura (Fig 6). This incision passes through the bed of the twelfth rib and the attachment of the diaphragm, which in some instances is quite a definite structure, whereas in others it is represented only by a few frayed muscle fibres. After the diaphragm has been incised, the renal fascia is encountered (Fig 7). This is continuous above and anteriorly with the posterior parietal peritoneum

## Summary of Cases in Present Report

CASE NO.	AGE	COLOR	SEX	ORIGINAL LESION	DIAGNOSIS ELIMINATED	SUBPERITONEAL OPERATION	LOCATION OF ABSCESS	COMPLICATIONS	RESULT
1	26	C	M	9/8/32 Perforated peptic ulcer	+ 10/9/32	10/26/32 Retroperitoneal through bed of 12th rib	Rt posterior superior	Bronchopleural fistula	Recovered
2	43	C	M	11/24/29 "	"	+ 12/14/29 Transpleural	Rt anterior superior and rt posterior superior	Pleura opened - empyema	Died
3	39	C	M	5/1/31 "	"	+ 5/1/32 Transperitoneal	Left anterior inferior		Recovered
4	40	M	M	2/4/29 "	"	+ 4/16/29 Retroperitoneal through bed of 12th rib	Rt posterior superior		Recovered
5	39	C	L	6/3/27 Appendiceal abscess	+ 6/6/27	Transpleural	Rt posterior superior		Recovered
6	16	C	F	8/28/22 Appendicitis	+ 9/12/22	Retroperitoneal below 12th rib	Retroperitoneal		Recovered
7	58	M	M	3/1/23 Perforated peptic ulcer	+ 4/6/23	Retroperitoneal through bed of 12th rib	Rt posterior superior		Recovered
8	24	M	M	9/29/30 Cholecystitis		10/10/30 Transperitoneal	Right inferior		Recovered
9	9	L	L	1/6/33 Acute appendicitis	+ 1/10/33	Anterior extraperitoneal	Rt anterior superior and rt posterior superior		Recovered
10	30	C	M	6/1/24 Empyema	+ 11/15/24	Transpleural	Rt posterior superior	Pneumonia	Recovered
11	26	C	F	5/27/24 Acute pelvic inflammation		7/28/24 Transpleural		Pleura opened - empyema	Died
12	48	M	M	2/4/31 Perforated gastric cancer	+ 2/24/31	2/26/31 Retroperitoneal	Rt posterior superior and right inferior	Parotitis pneumonia	Died
13	34	C	M	5/12/26 Pneumonia	+ 6/29/26	7/10/26 Transpleural	Rt posterior superior	Empyema	Died
14	23	M	F	9/1/26 Abortion	+ 10/13/27	10/17/27 Transpleural	Rt posterior superior	Pleura opened - empyema	Died
15	39	M	M	8/1/23 Cholecystitis		8/26/23 Transpleural	Rt posterior superior	Pleurisy	Recovered
16	40	C	L	2/27/32 Perforated peptic ulcer	+ 2/29/32	3/8/32 Retroperitoneal through bed of 12th rib	Rt anterior superior		Recovered
17	18	L	L	6/15/32 Lobar pneumonia (left)		7/23/32 Retroperitoneal below left 12th rib	Left retroperitoneal		Recovered
18	41	M	M	8/1/31 Operation for sinusitis	+ 10/14/31	11/8/31 Retroperitoneal below 12th rib	Left superior	Pleurisy	Recovered
19	32	C	M	8/25/27 Acute appendicitis	+ 1/30/28	2/2/28 Transpleural	Rt anterior superior and rt posterior superior	Empyema	Died
20	30	C	M	2/25/28 Cholecystitis	+ 4/27/28	5/9/28 Transpleural	Rt posterior superior	Pneumothorax and pleurisy	Died
21	35	M	M	6/20/28 Typhoid fever and pneumonia	+ 8/8/28	8/11/28 Retroperitoneal through bed of 12th rib	Rt posterior superior	Pleurisy	Died
22	17	M	M	10/8/32 Acute appendicitis	+ 10/30/32	10/30/32 Retroperitoneal through bed of 12th rib	Rt posterior superior		Recovered
23	18	M	M	2/1/33 Trauma of right lumbar region		3/10/33 Retroperitoneal through bed of 12th rib	Retroperitoneal		Recovered

## SUBPHRENIC ABSCESS

CHARR V II—An analysis of personal files  
12th rib



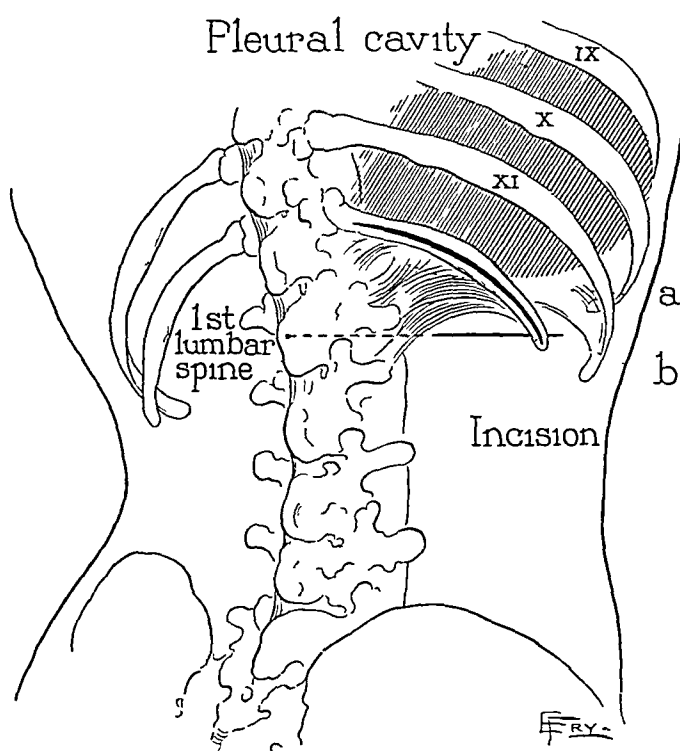


FIG 3—Diagrammatic drawing showing skin incision made over and parallel to the twelfth rib and transverse incision through the lumbar fascia and diaphragm at the level of the first lumbar spinous process

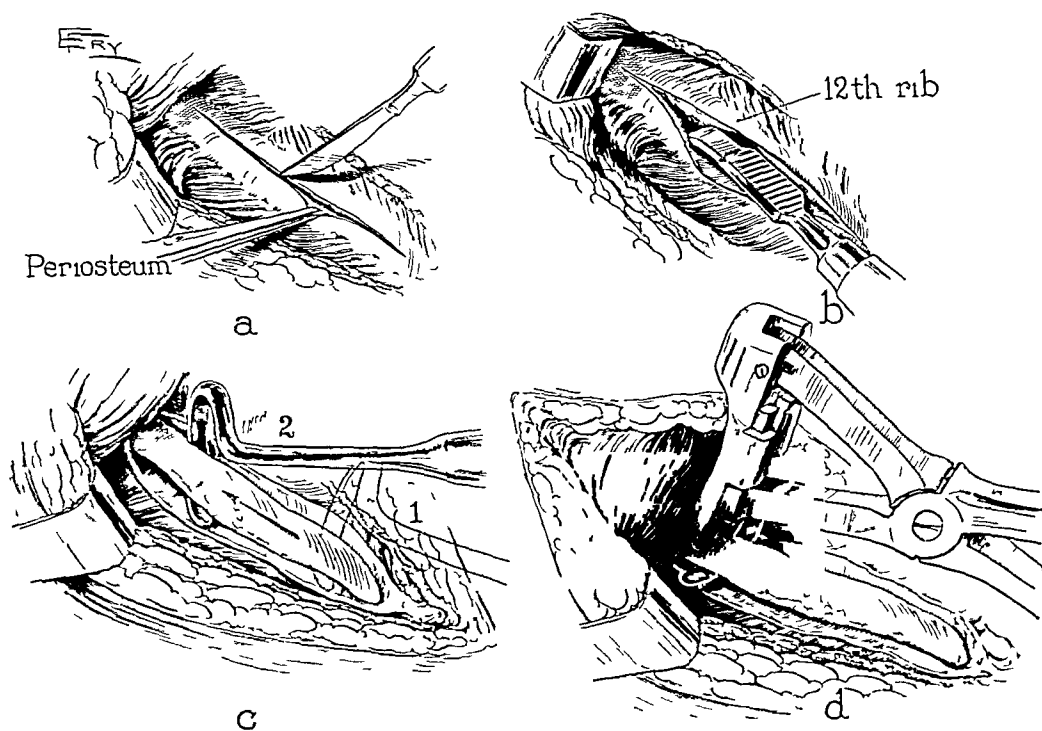


FIG 4—Subperiosteal resection of the twelfth rib throughout its entire length

# SUBPHRENIC ABSCESS

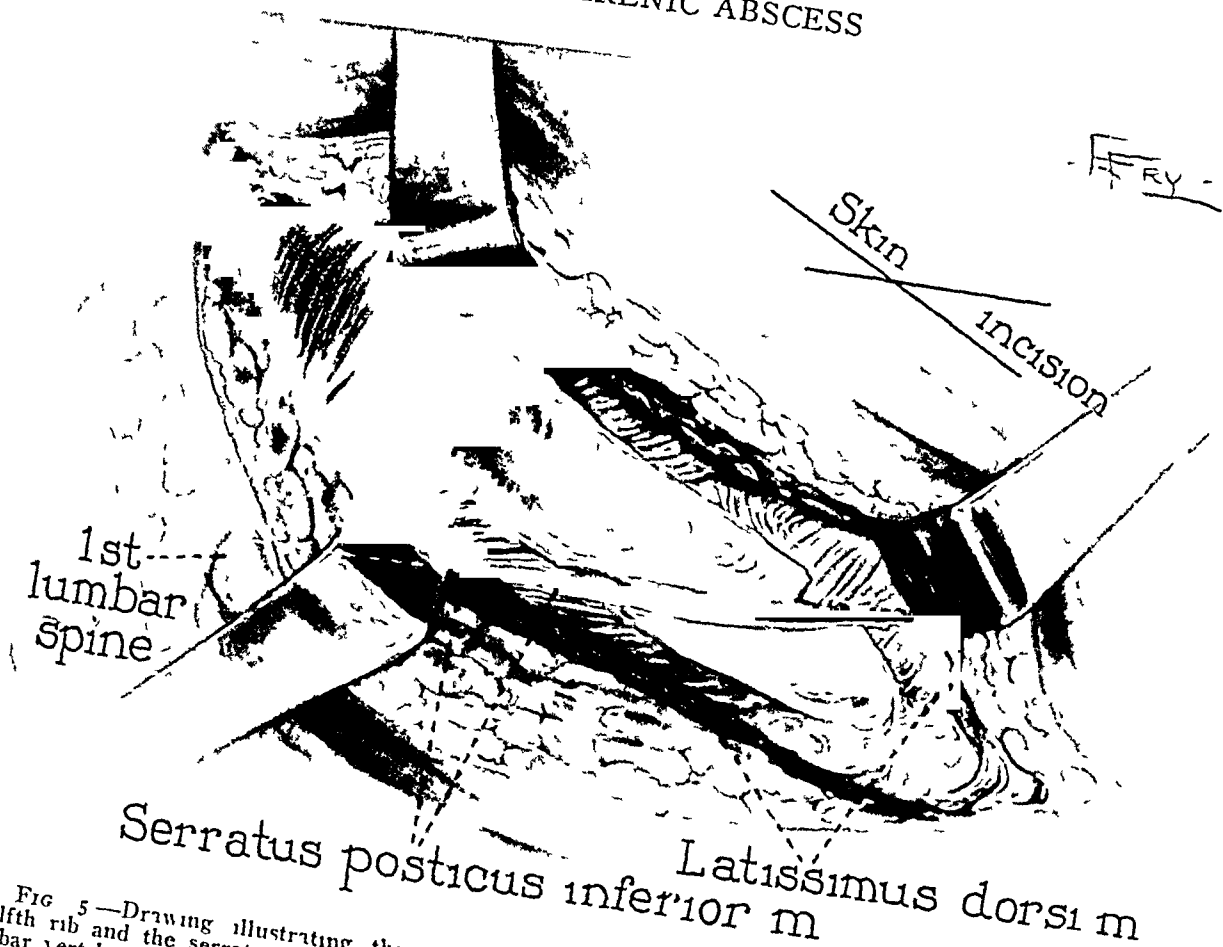


FIG 5—Drawing illustrating the transverse incision made through the resected bed of the twelfth rib and the serratus posterior inferior muscle at the level of the spinous process of the first lumbar vertebra. It is important that this incision does not parallel the original skin incision.

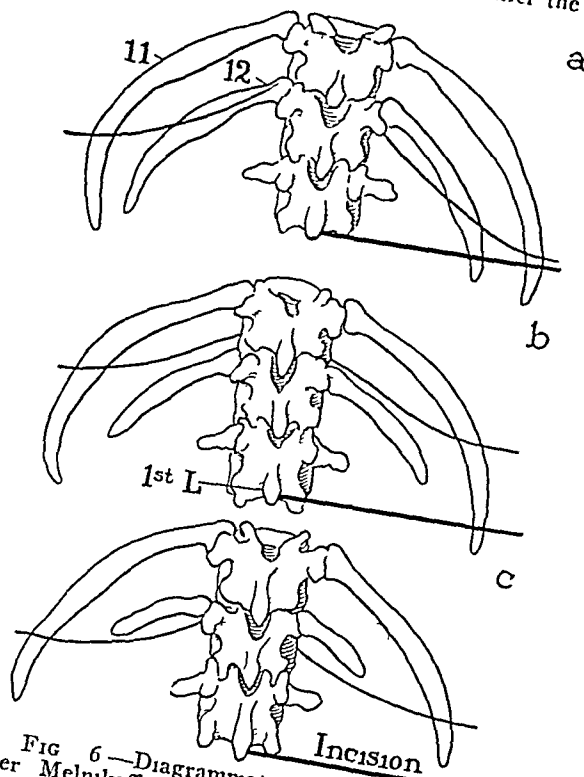


FIG 6—Diagrammatic drawing modified after Melnikoff, showing the variation in the relation of the costophrenic angle to the twelfth rib. It is evident that the transverse incision made at the level of the spinous process of the first lumbar vertebra will invariably miss the pleural reflection.

The kidney is displaced downward by means of the index finger and the infrahepatic space is palpated. If the symptoms and signs indicate and if at the time of operation an induration is found in the infrahepatic space, aspiration should be done in order to determine whether a suppurative process is present or not. In those cases in which a right posterior superior space abscess is suspected, the peritoneum on the undersurface of the diaphragm can be readily separated from the diaphragm by means of the finger (Fig 8). This separation is readily executed in cadavers and in normal subjects and especially easily in patients with a subphrenic abscess. The inflammatory oedema which is invariably present greatly facilitates mobiliza-

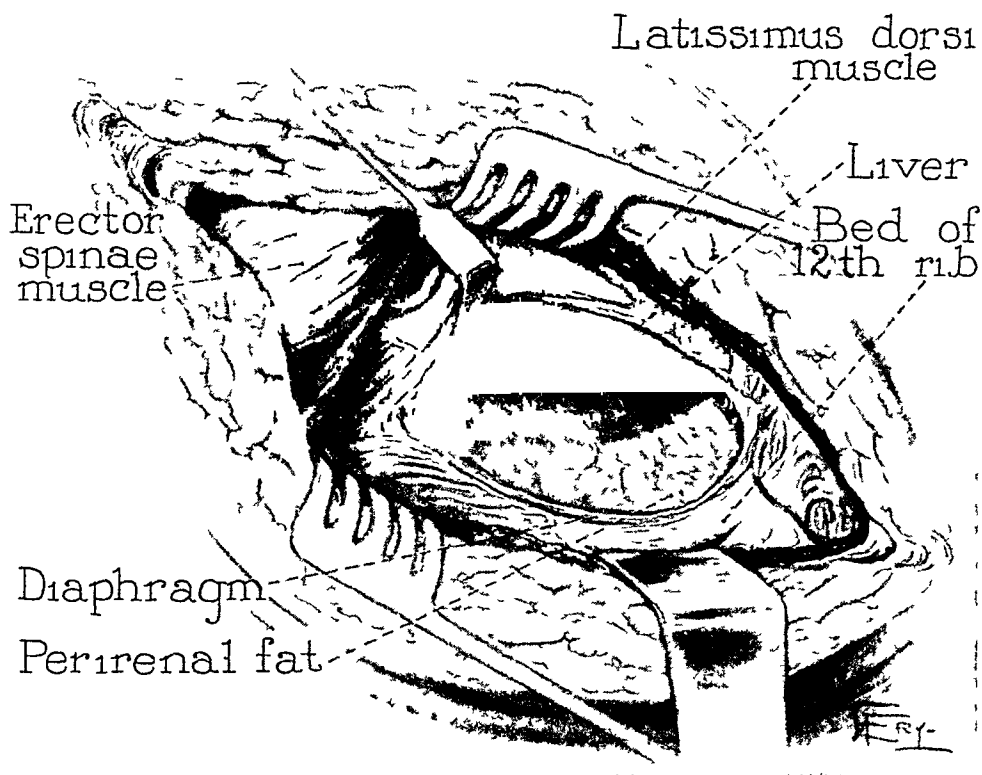


FIG 7—Drawing illustrating the operative wound following the transverse incision through the diaphragm at the level of the spinous process of the twelfth lumbar vertebra, exposing the perirenal fascia and the liver

tion of the diaphragmatic peritoneum from the undersurface of the diaphragm. This separation may be carried upward as far as the dome of the liver and should be extended until the abscess is reached. By means of the mobilizing finger the abscess cavity is opened by plunging the finger through the abscess wall which is adherent to the mobilized parietal peritoneum. Large, soft, fenestrated rubber tubes are introduced into the abscess cavity and brought out through the wound. Through this incision adequate evacuation of abscesses located in the right posterior superior, right extraperitoneal, the right inferior, and even occasionally right anterior superior spaces may be accomplished without traversing or contaminating either the pleural or peritoneal cavities. The advantage of the retroperitoneal operation is exem-

# SUBPHRENIC ABSCESS

**SUBPHRENIC ABSCESS**

plified by the results obtained in a total of thirty-one cases, nineteen of which were previously reported, of which three died, giving a mortality rate of 97 per cent (Graph VI) Two of the deaths were probably unavoidable as in each the patient died as the result of the original lesion, which in one was carcinoma of the stomach (Case XII) and in the other was typhoid fever (Case XXI)

Abscesses located in the right anterior superior, left anterior inferior, and the posteriorly.

Abscesses located in the right anterior superior, the right inferior, the left anterior inferior, and the left superior spaces can be drained extrapleurally through the anterior abdominal wall. Obviously, however, the

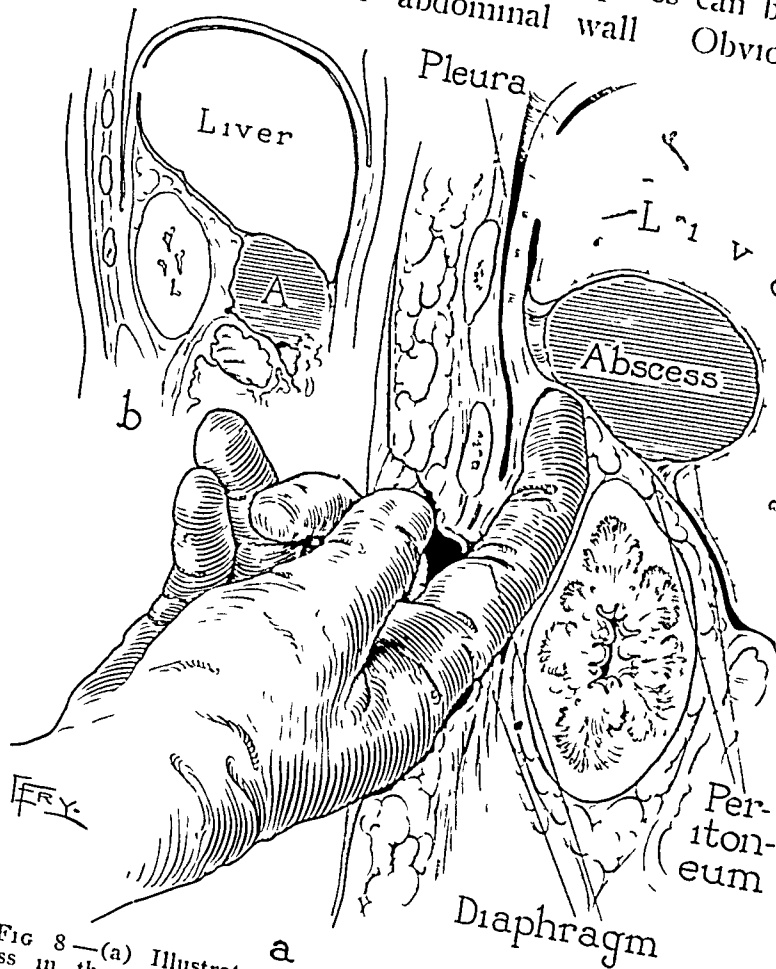


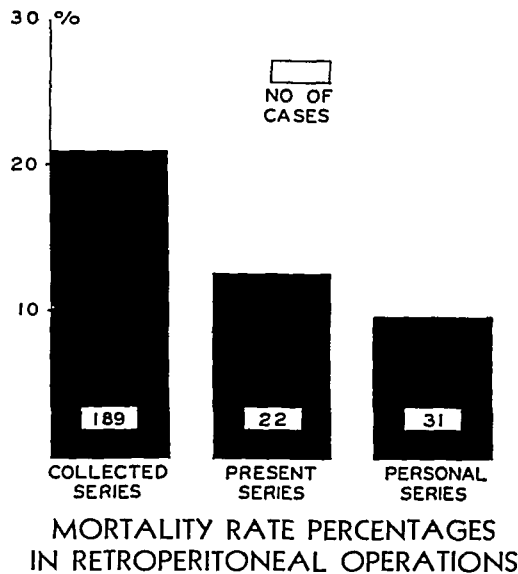
FIG 8 — (a) Illustration showing the method of approach to an abscess in the right posterior superior space. By means of the finger the peritoneum is peeled from the undersurface of the diaphragm until the abscess cavity is reached. By plunging the finger through the abscess wall the abscess may be drained without contaminating the pleural or peritoneal cavity. Insert (b) shows location of a right inferior space abscess which may be drained simultaneously through the same incision.

anterior route of drainage would not be used in cases with right inferior space abscesses if retroperitoneal drainage is employed, because these abscesses can be drained satisfactorily by the retroperitoneal approach. In those cases (usually the right anterior superior and the left superior space infections) with abscesses above the liver, the suppurative process can be approached and drained extra-peritoneally without contaminating uninvolved pleura or peritoneum by employing an approach suggested by Clainmont<sup>70</sup>. An incision just beneath the parallel to the costal margin is made through the flat abdominal muscles and transversalis fascia down to the anterior parietal

peritoneum Similarly as in the retroperitoneal operation the parietal peritoneum is separated from the undersurface of the diaphragm by means of the index finger (Fig 9) The peritoneum is mobilized upward until the abscess cavity is reached The cavity is opened extraperitoneally through the abscess wall which is intimately adherent to the mobilized parietal peritoneum Soft rubber drainage tubes or sheets of rubber tissue are introduced into the abscess cavity and brought out through the wound In the present series there were three cases so treated, all of which recovered

*Summary*—(1) An analysis of 3,322 cases of subphrenic abscess collected from the literature and a presentation of fifty additional cases is made

(2) The incidence of subphrenic infections is relatively high, but as



GRAPH VI—Graphic representation of results obtained by retroperitoneal operation in the collected series in the cases contained in the present report and in personally operated cases

most of these infections subside spontaneously and do not progress to supuration, the incidence of subphrenic abscesses is much lower

(3) The incidence of subphrenic abscesses in males is higher than in females, a ratio of three to one There is no racial predisposition Seventy per cent of the cases in the present report were in the second to the fourth decades, inclusive

(4) Subphrenic abscesses usually follow an intraperitoneal suppurative process The most frequent antecedent conditions are perforated appendicitis and perforated lesions of the stomach and duodenum In the collected and personally reported cases, appendicitis and perforated lesions of the stomach and duodenum were the originating focus in 59 per cent and 54 per cent of cases, respectively

(5) The most frequent site of localization in subphrenic abscesses is the right posterior superior space, which was involved in 28.8 per cent of the collected series and 60 per cent of the cases in the present report

(6) Diagnosis of subphrenic abscess is apt to be delayed because of the

## SUBPHRENIC ABSCESS

inaccessible position of the abscess. Signs of persistent infection together with localized tenderness over the twelfth rib or along the costal margin suggest subdiaphragmatic infection. Diaphragmatic elevation and immobilization are of diagnostic importance.

(7) Subphrenic infections should be treated conservatively, because only approximately 30 per cent progress to suppuration.

(8) Subphrenic abscesses should be drained surgically. In the collected

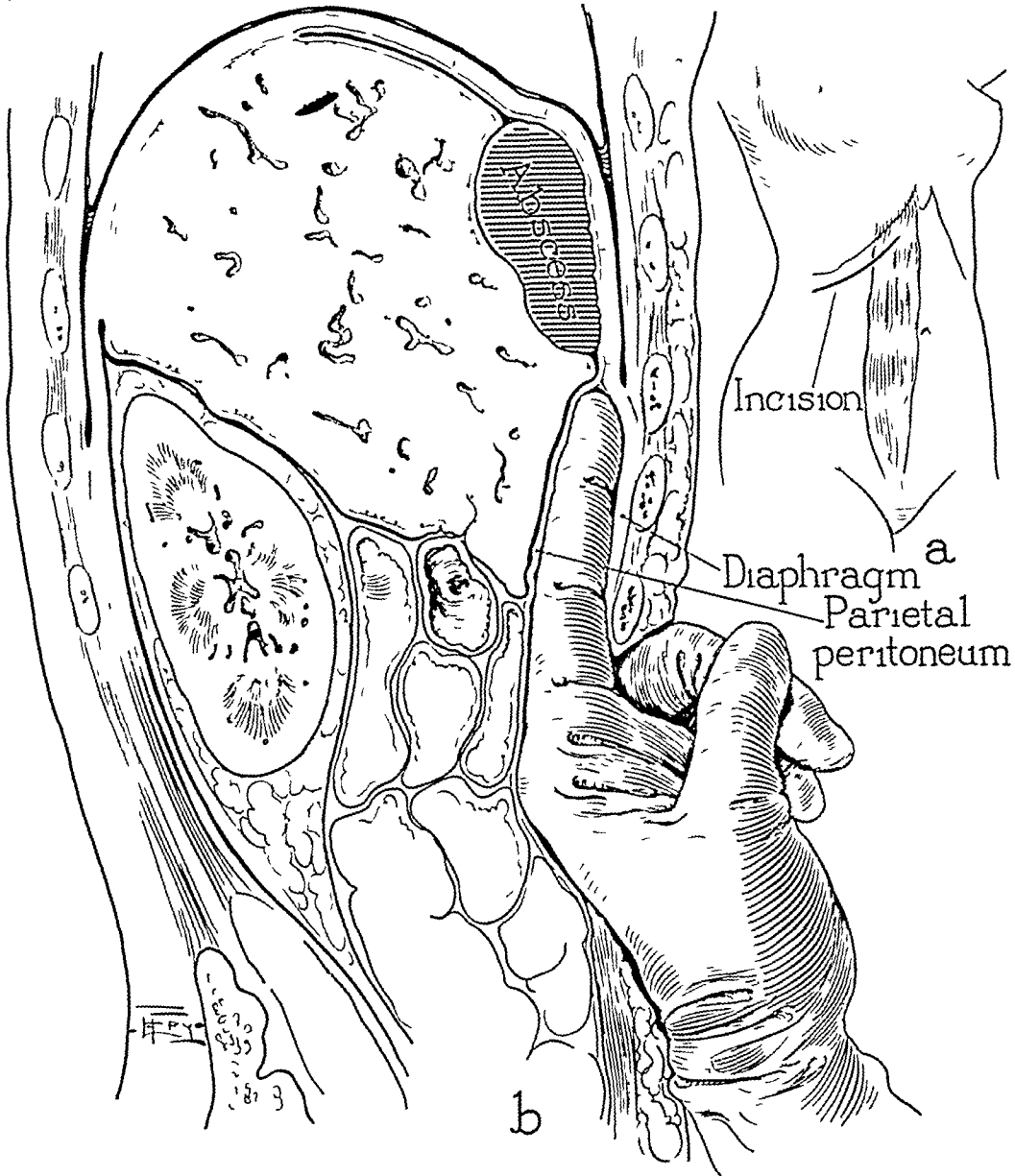


FIG 9—Illustration showing the method of draining extraperitoneally an abscess in the right anterior superior space. As shown in (a) an incision is made below and paralleling the right costal margin, passing through the flat abdominal muscles and the transversalis fascia. By means of the finger the parietal peritoneum is peeled from the undersurface of the diaphragm until the abscess cavity is reached. The abscess is then drained extraperitoneally without contaminating either the pleural or the peritoneal cavity.

cases treated non-operatively there was a mortality rate of 91.1 per cent. In the collected cases treated by drainage the mortality rate was 33.6 per cent. The mortality rate in the present series was 32 per cent.

(9) The mortality rate in the collected cases drained transpleurally was 39.0 per cent, as contrasted with a mortality rate of 21.1 per cent in those cases drained without contaminating the pleura or peritoneum. The mor-

tality rate following transpleural drainage in the present series was 50 per cent

(10) Of the cases drained transperitoneally the mortality rates in the collected and present series were 35.5 per cent and 41.6 per cent, respectively

(11) The mortality rates in cases drained retroperitoneally in the collected and present series were 21 per cent and 13.6 per cent, respectively

(12) In order to decrease the mortality in cases of subphrenic abscess, it is necessary that contamination of uninvolved portions of the pleura and peritoneum be avoided during drainage of the abscess. This can be accomplished best by draining the abscess extraperitoneally

(13) The technic of the retroperitoneal operation is described and its value exemplified by the low mortality rate obtained following its use in thirty-one personally operated cases (9.7 per cent)

We are grateful to those surgeons of the staffs of both the Charity Hospital and Touro Infirmary for some of the cases included in this report

The authors are indebted to Dr. Ray Zeck for his preparation of a personally operated case and the privilege of including one of his cases in the present report

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DISCUSSION —DR HOWARD LILIENTHAL (New York City) said there is one very important method of making a diagnosis of subphrenic abscess that has not been mentioned. He referred to the production of pneumoperitoneum, followed by X-ray examination with the patient in the erect position and also lying on the well, or supposedly well side. One gets an almost certain diagnosis not only of the abscess but of adhesions of the liver to the diaphragm. It is something that ought not to be omitted in suspected subphrenic abscess.

Concerning a point of technic in the operation, Dr Charles A. Elsberg devised a posture very much like the knee-chest position, with a nice big pillow to compress the abdomen. We make an incision *upon* the ninth or tenth rib subperiosteally, very carefully, and push the pleura away. Remember the pleura is stripped easily posteriorly but it is difficult to push the pleura away anteriorly. Seldom one enters the thorax. If the pleura is accidentally violated, the tendency is for the air to remain away from the apex. Through a large incision exposure is good. The diaphragm is clearly visible and one can put a needle in and make an exact exploration. The abscess then can be freely opened. You can put your finger in or your whole hand and find secondary abscesses if these are present. He had opened liver abscesses also in this way. The reason why we go into the ninth or the tenth rib region is because 'in the usual subphrenic abscess the diaphragm is pushed far up, as you can see by the X-ray, in the presence of pneumoperitoneum. The incision must not be made too low. His preference is for the ninth rib.

DR ARTHUR DEAN BEVAN (Chicago, Ill.) suggested that instead of resecting the twelfth rib, the incision be made and then the two gloved hands introduced and the structures stretched widely apart, and the neck of the twelfth rib either fractured or pulled loose from the ligaments which attach the twelfth rib to the transverse process. He had used that technic for a number of years. It is a very simple matter. After the transverse incision is made the two hands are introduced and then with some power the neck is either fractured or torn loose from the transverse process.

DR ALTON OCHSNER (New Orleans, La.) said he had attempted on the cadaver to mobilize the pleura from the diaphragm as one mobilizes the peritoneum from the under surface of the diaphragm. It is quite evident, however, that at least in the cadaver the pleura is more intimately adherent than is the peritoneum to the diaphragm. Therefore, there is less danger, he believed, in opening an uninvolved serous cavity by the retroperitoneal approach.

In their particular series of cases in the transpleural group there were two in which at the time of the original operation the surgeon had sutured the diaphragmatic and thoracic layers of pleura together. In each one of these instances, even though suture had been done, a fatal empyema resulted. That may have been poor technic and probably was, but still he believed that a transpleural approach will not give as good results as will an extraserous approach. The danger of opening the pleura can be obviated if one will use a transverse incision at the level of the spinous process of the first lumbar vertebra. Doherty and Rowlands suggested resecting only the distal half of the twelfth rib. He tried this in one case. In this particular instance the diaphragm was high. The abscess was high and he could not approach it until he resected all of the rib.

Frequently as in a kidney approach, unless one does resect the twelfth rib, one has difficulty in gaining access to the upper pole of the kidney. If one will strictly adhere to the transverse incision at the level of the spinous process of the first lumbar vertebra he was sure, based on Melnikoff's and his own anatomical investigations, that there is no danger of opening the pleura.

# INJURY AS A CAUSATIVE FACTOR IN THE DEVELOPMENT OF MALIGNANT TUMORS\*

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ONE of the most difficult questions that confront the industrial commissions today is What part, if any, does injury play in the development of malignant tumors? While numerous papers have been written on the subject and it has formed the chief topic of discussion at national and international congresses, no definite conclusions have been reached, at least, none that has been universally accepted. The judges and commissioners who have listened to the opinions of medical experts have found it exceedingly difficult to balance these more or less conflicting opinions. Since the adoption of the Workman's Compensation Act, not only in this country but in Europe, there has come up for adjudication a rapidly increasing number of cases in which a claim for compensation has been made on the ground that a local injury was the exciting cause of a subsequently developing malignant tumor.

The most difficult thing in discussing any medical question, especially a medico-legal question, is for the physician or surgeon to preserve a judicial attitude and to bear in mind that the attitude of an advocate has no place in a scientific discussion. While this is an ideal we have not yet attained, it is a goal toward which we should aim.

During the last twenty or more years a great change has taken place in the attitude of the medical profession toward the question of trauma and its relation to malignant tumors. Many who formerly refused to admit a causal relationship have since become convinced by the steadily increasing evidence, too conclusive to admit of question. Furthermore, it has been definitely accepted by the courts and compensation bureaus not only in the United States but in most other countries as well.

In France, the whole question took on importance from a medico-legal standpoint as early as 1897. Then the first law was passed. This outlined certain conditions the fulfillment of which meant the establishment of a causal relationship between an antecedent local trauma and a subsequently developing tumor. In 1907, at the French Congress of Surgeons, Segond read his classical paper on the subject, in which he presented six conditions, which conditions or rules have been accepted not only by the courts and compensation bureaus of Europe but of America as well, they have been accepted by Ewing in his book on "Neoplastic Diseases."

These conditions imply the following (a) The authenticity of the trauma (b) Sufficient importance or severity of the trauma (c) Reasonable evidence of the integrity of the part prior to the injury (d) Correspondence of the

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\* Read before the American Surgical Association, May 10, 1933

tumor to the site of the injury (e) A date of appearance of the tumor not too remote from the time of the accident to be reasonably associated with it (f) A diagnosis established by clinical and histogenological evidence supported when possible by microscopical examination

The frequent association of trauma with malignant tumors impressed itself upon one of the writers (W B C ) as early as 1897,<sup>1</sup> when he presented a paper on the "Influence of Injury upon the Development of Sarcoma" before the New York Surgical Society. In this paper he analyzed 170 cases of sarcoma personally observed, forty-six of which gave a definite history of antecedent local injury. In 1910,<sup>2</sup> in a paper on "Injury as a Causative Factor in Cancer," he discussed the question more fully. At this time he reported 970 cases of sarcoma personally observed, in which there was a history of antecedent local trauma in 225, or 23 per cent, and 250 cases of carcinoma, in which there was a history of injury in eighty-two cases, or 32.8 per cent. Of the latter group, 120 were breast carcinomas, of which fifty-two, or 42.33 per cent, gave a history of single antecedent trauma. A careful analysis of cases observed since that date shows about the same trauma-percentage in a group of 360 cases of bone sarcoma personally observed from 1890 to 1926,<sup>3</sup> 181, or 50 per cent, gave a definite history of antecedent local injury. Since the publication of that paper we have observed 100 additional cases, making a total of 280 cases of sarcoma of the long bones associated with antecedent local trauma.

One of the reasons why the profession has been slow to accept the traumatic theory of tumors is because of the general skepticism on the part of the pathologists who, unable to find what they believe to be a clear or rational explanation of such causal relationship, have been inclined to attribute it to coincidence of a pre-existing tumor. We must bear in mind, however, that the pathologist does not come in direct contact with the patient, at least not in the early stages of tumor development. He has no first-hand information on which to base his opinion. On the other hand, the surgeon makes a physical examination. He learns on questioning the patient that the latter sustained an injury to a hitherto normal part, and that this exact part in the course of a few weeks or months has become the site of a malignant tumor. He cannot help but be impressed with the importance of the alleged injury and its possible relationship to the later-developing tumor.

In our opinion, the part that trauma plays in the etiology of malignant tumors is closely associated with the wider problem of the etiology of malignant tumors in general. We know that while a vast amount of study and research work has been done in an attempt to discover the cause of cancer, it still remains an unsolved problem. While the majority of pathologists at the present time undoubtedly believe cancer to be due to intrinsic causes (cellular theory), a considerable, and, we believe, increasing number, including surgeons who have had a large clinical experience with cancer in man, believe it is due to some extrinsic agent or microbic cause (parasitic theory).

In view of the increasing number of individuals who attribute their con-

## INJURY CAUSING MALIGNANT TUMORS

dition malignant tumor, to an antecedent local injury, it becomes more and more urgent for us to try to find out just what, if any, causal relationship does exist between the alleged trauma and the tumor. We cannot wait until the general problem of the etiology of cancer has been finally and convincingly settled.

*Etiology of Malignant Tumors*—At present the profession at large, especially those engaged in cancer research, are divided into two main groups. The first and larger group maintains that malignant tumors are due primarily to some *intrinsic* cause, such as a congenital rest, or causes associated with the but little understood processes of cell development and cell restraint. Take, for example a fracture. Here we find an immediate and very great out-pouring of new cells which form a callus or splint about the broken ends of the bone, and this callus quickly undergoes ossification with complete restoration of function. Why does this rapid multiplication of cells cease at the precise moment when no more are needed for the process of repair? We do not know, but we assume that there is some law called *growth-restraint*, which causes the process of proliferation to cease as soon as the damage has been repaired. Apparently Nature has some laws that govern the life and the death of cells. New cells are constantly being formed to take the place of old cells that have died or have been damaged by trauma, and when the damage has been repaired, the production of new cells ceases. In the case of a malignant tumor, however, the law of *growth-restraint* no longer functions. The multiplication of cells continues indefinitely, the new cells drawing their nutriment from the normal neighboring cells, thus weakening the individual until he finally dies of exhaustion or metastases.

In our opinion, there never has been any satisfactory explanation of the breaking down of the law of *growth-restraint*, nor of the difference in behavior of cells and tissues undergoing repair and those in the early stages of malignancy.

If we accept the theory of the intrinsic origin of cancer, the best explanation of the causal relationship of trauma is found in Ewing's book on "Neoplastic Diseases," third edition, p. 116. He states

"Important effects of trauma here are (1) Solution of continuity, minute and gross, (2) separation of cell groups and tissue masses, as of skin, glands, bone, (3) necrosis of tissue, (4) confined hemorrhage requiring absorption or encapsulation, (5) accelerated regenerative processes with hyperemia, and new growth of specific cells blood-vessels, and supporting tissue, (6) cicatrization.

"Some of these conditions are well-known elements entering into the causation of tumors, and the failure of attempts to produce tumors by experimental trauma in given cases does not reduce their importance when associated with other necessary predisposing factors."

The second and smaller group believes that all malignant tumors are of parasitic origin due to some unknown intracellular microorganism. If we accept the parasitic origin of cancer, the explanation of trauma as a causative factor is simple, rational and logical. The trauma furnishes a favorable soil for the growth of the organism. We have merely to assume that an extrinsic

microorganism or infectious virus has in some way, through the circulation, gained access to the cell where it acts as an irritant, causing rapid proliferation and multiplication of the cells. All the new cells contain a similar microorganism. This process continues indefinitely until a malignant tumor is formed. The latter increases in size and finally causes the death of the individual.

On this assumption we can explain the development of metastatic tumors in other parts of the body. The tumor progresses in size, new blood-vessels and blood spaces are formed into which the tumor-cells frequently gain access and are carried to distant parts of the body, thus forming the nucleus of a metastatic tumor. That this latter tumor has the same histological features as the primary tumor is explained on the ground that the organism is an intracellular organism, and both the cell and the organism are transported through the circulation, thus producing a new tumor of the same type of cell as the original.

*Theory Held by Dr. William B. Coley*—This theory, already described in detail in a paper read before the American College of Surgeons, in 1924, is briefly as follows. That there exists an unknown microorganism or several strains of this microorganism which is widely distributed throughout the world so that practically everybody is exposed to it, and yet it requires a favorable soil for its development into a malignant tumor. I do not think the question of "favorable soil" has ever received due recognition in discussions on the etiology of cancer. In a paper ("Some Thoughts on Cancer Control," American Journal of Cancer, February, 1928), I gave a more detailed account of this theory and cited the evidence in favor of it.

I suggested in 1924 that a similar explanation might be applied to the causation and development of malignant tumors. This would explain why everybody does not contract the disease—only those whose local resistance has been broken down by one of many factors, *e g*, local trauma or chronic irritation or some change in the chemistry of the body fluids possibly due to changes in diet or water.

Another condition that furnishes a close analogy is osteomyelitis. About one-third of the cases of acute osteomyelitis give a history of antecedent local trauma. Furthermore, it has been possible to produce the same result experimentally by injecting a rabbit with cultures of *staphylococcus aureus*, no harm results, and yet if following the injection the rabbit receives a sharp blow on the tibia or some other bone, osteomyelitis quickly develops.

We may assume that malignant tumors in man are due to a microorganism that is latent in the circulation and which gives rise to symptoms of malignancy only after the normal resistance of the cells is broken down, in some instances by local trauma. The microorganism thus finds a suitable soil in the damaged cell, forming a symbiosis with the cell and causing a proliferation and multiplication resulting in a malignant tumor.

One of the strongest arguments in favor of the parasitic theory is the inhibitive and even curative action of the streptococcus of erysipelas upon various types of malignant tumors. As early as 1893, one of the writers

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(W B C) stated he could find no rational explanation of this action except on the assumption that malignant tumors themselves are caused by some type of microorganism

Recently Bouveret,<sup>4</sup> of Lyon, France, published an important monograph on the "Pathogenesis of Cancer," in which he strongly maintains that cancer is an infectious disease due to some form of microorganism, probably to some strain of streptococcus of erysipelas. He bases his argument chiefly upon the inhibitive and curative effect of erysipelas upon malignant tumors, and believes that this action can be explained in no other way.

Another strong advocate of the parasitic theory is Gregoraci, of Naples.<sup>5</sup> He believes that the body-cells and tissues of every individual have either an inherited or an acquired defense against bacterial infection. He states that while microorganisms may occasionally cause an acute infectious process accompanied by fébrile reaction, they more often in an ultramicroscopic state install themselves in the intimate texture of the tissues or cells and await a suitable soil for further development. Having found a permanent habitat, either isolated or in association with other organisms, they proceed to draw their nourishment from the body cells.

A critical study of the whole question of trauma and tumors has recently been made by Dr. Leila Charlton Knox,<sup>6</sup> of St. Luke's Hospital, New York. Knox's main argument against accepting a single local trauma as a causative agent in cancer is based upon the fact that in a large amount of experimental work by Lubarsch,<sup>7</sup> Ribbert<sup>8</sup> and others, it was found impossible to produce a cancer by any form of local trauma.

The large number of clinical observations covering a period of nearly one hundred years which, in our opinion, furnish convincing evidence of a causal relationship between injury and malignant tumors, Knox brushes aside as of little or no value. She gives the impression of being in accord with Askanazy,<sup>9</sup> who stated that the literature dealing with the subject was only a "collection of anecdotes." We doubt very much if the majority of students of this question will agree that the clinical observations made by the leading surgeons and pathologists of the world, beginning with Virchow in his classical book entitled *Die Krankhaften Geschwulste* (1863), and including a long line of distinguished pathologists and clinicians can be completely ignored or justly classed as "anecdotes."

According to Knox, Segond<sup>10</sup> discussed the statistical collections of case reports of tumors of alleged traumatic origin, and doubted that they have any value, quoting Auguste Comte to the effect that they represent only "empiricism under a mathematical disguise, for the most extensive statistics when they are derived from a variety of sources often have less value than fifteen minutes of good observation."

Quoting further from Knox "Ribbert,<sup>8</sup> who thought that all the statistical collections were without value, stated that well-studied single cases of this type might be more convincing than any heretofore published statistics."

With this statement of Ribbert we are in complete accord. The present paper is not a statistical collection of case reports gleaned from many hospitals, each one with its own system of history taking, but is a critical study of a large group of cases personally observed.

As we have frequently pointed out, the question is one in which the pathologist is less able to give a careful, judicial opinion than is the clinical surgeon, for the reason that he is always dealing with second-hand or hear-say evidence which in the court of law is regarded as of little or no value. Whereas the surgeon who sees the condition in the early stages and obtains a

first-hand account of the injury, if he is a practitioner of large experience and has a knowledge of human nature, is able to judge the credibility of the patient and to weigh the importance of the evidence. Scientific medicine has not infrequently made grave mistakes in ignoring the oft-repeated stories and beliefs of laymen simply because no satisfactory scientific explanation could be found for them. No better example of this can be found than in the discovery of the origin of tuberculosis. For hundreds of years the laity held a firm belief that tuberculosis was a contagious or infectious disease, but this the leading medical authorities denied. They based their opinion on innumerable statistics, chief of which were those of the Brompton Home for Tuberculous patients showing that in thirty-five years not a single nurse or doctor had contracted the disease. In the following year Koch discovered the tubercle bacillus.

*War Injuries*—Many writers who refuse to accept a causal relationship between injury and tumors base their contention on the almost complete absence of malignant tumors following war injuries. Shortly after the World War, Dr. John B. Walker (a Colonel in the American Army) sent us notes on fifty-six cases of sarcoma that were associated with recent fractures or gunshot wounds. These were as follows:

- 39 cases of sarcoma of the femur and tibia treated by amputation, 23 dead
- 5 cases of sarcoma of the humerus treated by amputation, 2 dead
- 2 cases of sarcoma of the radius and ulna treated by amputation, 1 dead

In a study of material from the Sanitary Reports of the Prussian Army from 1899 to 1907, Lowenstein<sup>11</sup> found 241 cases of cancer, of these, thirty-nine, or 16.5 per cent, were post-traumatic. In view of the regular physical examinations made in these cases, exact data as to the time and locality of the injury were available.

Lowenstein, whose evidence Knox regards as more reliable than that of Lowenthal, in his monograph on "Accident and Cancer," reported 271 critically chosen cases, of which 121 proved to be sarcoma.

Another argument frequently advanced by opponents of the *traumatic theory* is, that the number of cases of local trauma occurring in the daily routine of life is very large, while the number of cases of malignant tumor associated with antecedent local trauma is very small. The statistics of accident wards of large hospitals showing thousands of injury cases with but few if any tumor cases, are cited.

This whole argument when properly analyzed loses most if not all of its force. To begin with, no one believes that trauma alone can produce a malignant tumor. Hence the large number of injury cases with but few malignant tumors. To produce a tumor, other factors are required, *e.g.*, a predisposition on the part of the individual, inherited or acquired, resulting in tissues or cells of too low-resisting power to withstand the invasion of the microbic cause of cancer. In some individuals this resisting power is so low that no external cause is required for the development of the cancer, in

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others, the natural resistance must first be lowered by some external force, such as local trauma or chronic irritation, before the disease can gain a foothold. Hence we should expect malignant tumors to develop not after all injuries but only when there is a co-existence of all the factors mentioned, which would account for the very small number of cases associated with antecedent local trauma. In poliomyelitis we find a close analogy. Here there is undoubtedly a microbial agent or virus, widely distributed, to which a great many are exposed, and yet, even in an epidemic, a comparatively few contract the disease. The explanation is, that nearly all adults and the great majority of children have a high degree of resistance or immunity to the organism. This resistance is either inherited, or acquired by having had an attack of the disease so light that it was never recognized.

As a matter of fact, we believe that the actual number of cases of malignant tumors in which there was some form of antecedent local trauma is considerably greater than the apparent number based on a study of hospital histories.

Two years ago, one of the writers was called upon in a single month to testify as expert in two cases of sarcoma that had recently been under his care at the Memorial Hospital or the Hospital for the Ruptured and Crippled. In one case no mention was made of antecedent local trauma, and in the other the house surgeon had stated that there was no history of trauma. In the latter case, the man had been thrown off a high ice wagon, striking his pectoral region upon a cobblestone pavement, a few weeks later a rapidly growing sarcoma developed at the exact site of the injury. In the former case, the patient had slipped while carrying a ladder under his arm, forcing the ladder against the soft tissues of his axilla and causing a bruise, shortly afterwards, a highly malignant tumor developed, at the exact site of the injury.

Fortunately, the writer had a complete personal history in these cases, with accurate description of the nature of the injury and the dates. A claim was brought against the insurance companies in both cases and full compensation was allowed.

If the errors in these histories had not been discovered, some later investigator of the question of trauma and cancer would have recorded both as cases without antecedent injury. If such events occur in hospitals in which a special effort has long been made to obtain exact information as to presence or absence of trauma in every malignant tumor, it is easy to believe that an even larger percentage of errors occur in the larger general hospitals.

Again, many pathologists base their opposition to a causal relationship between antecedent local trauma and the development of malignant tumors on the ground that so-called scientific or laboratory evidence of the integrity of the part at the time of the injury is lacking. Strictly, this would call for excision of tissue at the site and time of the trauma, for microscopical examination, which is manifestly impossible. On the other hand, the rules or conditions laid down by Segond call for no such laboratory proof but are satisfied with clinical and, when possible, roentgenological proof.



To cite a personal observation A man was struck a severe blow on the occipital region by a heavy wooden packing case, producing a typical hematoma two and one-half inches in diameter over the occiput Under two weeks' local treatment this diminished to about one-half its original size, it then began to increase An operation was performed three weeks after the injury for a supposed hematoma but instead there was found an osteogenic sarcoma which had completely destroyed both tables of the skull over an area two inches in diameter extending to the dura The diagnosis was confirmed by Doctor Ewing Under irradiation and Coley's toxins, the disease apparently disappeared At the end of seven and one half years, however, the patient is living with severe pain from radium osteitis, but no evidence of recurrence\* In this case there can be no reasonable doubt that the trauma was a causative factor in the development of the sarcoma To suppose a pre-existing tumor without any physical signs or symptoms in such a location calls for a stretching of credulity beyond the ordinary limits

In another case, a woman, while walking along the street, was struck a severe blow on the breast by a batted ball, causing a distinct bruise, ecchymosis, and severe pain No tumor or swelling had been noticed in this region prior to the injury, and none was noticed immediately thereafter However, two months later she developed a hard, rapidly growing lump at the exact site of the injury This was pronounced malignant A radical amputation was performed but the patient died a few months later In this case, to assume the presence of a pre-existing, unrecognized carcinoma at the exact site of the injury, in our opinion, again calls for an unreasonable amount of credulity

If such cases of clear-cut history of antecedent local trauma were rare or isolated the assumption of a pre-existing tumor might be warranted, but when we find the number increasing in direct proportion to the care with which the clinical histories are taken then we must look for some more rational or more probable explanation

Wainwright,<sup>12</sup> of Scranton, Pa, in his paper on "Single Trauma, Carcinoma and Workmen's Compensation," maintains that "If we will admit that the relationship has been a true one, even in one case, we must consequently admit that it may likewise be a possibility in any other case in which this relationship comes up for serious consideration"

According to Samuel Johnson, "Experience becomes the great test of truth and is perpetually contradicting the theories of men"

While Knox is but little impressed by Lowenthal's<sup>13</sup> paper on "The Traumatic Origin of Tumors," the latter after nearly forty years still remains one of the most exhaustive clinical studies of the subject that has ever been made It is based on a careful analysis of 800 collected cases reported since 1870, with references to 360 cases of malignant disease of undoubted traumatic origin reported prior to 1863 and cited in Virchow's "Pathologic Tumors" The latter, however, are not included in the statistical presentation of the 800 cases It is interesting to note that there were 137 cases of traumatic carcinoma of the female breast Of the 316 cases of sarcoma reported, 167 were sarcomas of bone

The time that elapsed between the trauma and the development of the tumor is stated in 190 cases, as follows one month or less, 135 cases, one month to one year, thirty-three cases, upwards of one year, twenty-two cases The longest interim stated was forty-nine years In a few cases from fifteen

\* Shortly after this was written, evidence of a local recurrence appeared and developed rapidly causing death in September, 1933, eight years after the treatment was begun

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to thirty-four years elapsed before the tumor was noticed Lowenthal gives a brief history of all these 800 cases

*Carcinoma*—While a causal relationship between a single trauma and sarcoma had been more or less generally accepted, the English courts up to 1912 declined to accept any such causal relationship in cases of carcinoma The first report of a legally established case of traumatic carcinoma of the breast we owe to W Sampson Handley,<sup>14</sup> Hunterian Professor of the Royal College of Surgeons, London, who has long been regarded as the leading authority on cancer of the breast in Great Britain

According to Handley, this patient, a woman, was referred to him on March 26, 1912 She stated that on November 3, 1911, she had fallen over a beam, striking on the left elbow and the left breast The arm had to be kept in a sling for three weeks About January 1, 1912, she first noticed a discharge from the left nipple, and shortly afterwards a small lump was seen in the left breast, which proved to be a large, malignant, rapidly growing duct carcinoma

The case was tried and "the jury found for the plaintiff and awarded 200 pounds damages"

Janet Lane-Claypon, one of the foremost English authorities on cancer of the breast, who was selected by the British Ministry of Health to help compile the "Public Health and Medical Subjects" in 1924 and 1926, took charge of the investigation of cancer of the breast She analyzed the histories of 508 cases of cancer of the breast selected from the leading hospital in London In this number she found a definite history of antecedent local injury in 136 cases, or 26.77 per cent

She divides the entire series into two groups, *e g*, *Group A*, in which there was a definite history of trauma followed by bruising, and *Group B*, in which there was a definite history of trauma without bruising, at least no statement of evidence of bruising was made in the history

*Group A* contains forty-one cases These she compares with a group of controls or 1,526 non-cancerous breast cases which showed only thirteen cases in which there was a history of bruise with cancer, the difference being 52.3 to 5.9 per cent In Lane-Claypon's opinion the results of this study would lead one to believe that there was a definite association between injury and the subsequent development of cancer of the breast

*Group B*, containing ninety-five cases, was compared with 1,526 controls or non-cancerous breast cases in which only eighteen gave a history of previous injury A comparison of the two groups shows 62.6 per cent of the positive cancer cases with a history of injury and 3.57 per cent of the controls

In a study of one hundred consecutive cases of carcinoma of the breast observed at the Presbyterian Hospital, McWilliams<sup>15</sup> found a history of antecedent local trauma in 44 per cent

Our own personal series of 205 cases of carcinoma of the breast shows seventy cases in which there was a definite history of local trauma or in which the conditions laid down by Segond were practically fulfilled, seventy-one cases in which it was definitely stated that there had been no antecedent injury, and sixty-four cases in which no notation was made as to the presence or absence of trauma Considering only the seventy cases in which there was a definite history of trauma and assuming that the sixty-four cases in which no statement was made were not associated with injury, we have 34.1

per cent of the entire series in which there was a history of antecedent local trauma

The role played by trauma in the development of metastases in latent carcinoma has been discussed by Firket of the University of Liege, who reports an unusual case, one of the few on record, that illustrates this point. His patient, a woman aged forty-five years, had a carcinoma of the rectum for which he performed a radical Kraske operation in the spring of 1912. The patient made a complete recovery and remained in good health without any symptoms of disease in any other part of the body until May, 1916, when she let fall on her foot a heavy earthen bowl. While there was no open wound, a very definite, painful contusion developed almost immediately afterwards. The severe pain never subsided, and two months later, a definitely outlined, hard, non-fluctuating tumor could be made out. *Röntgen-ray diagnosis*—Tubercular osteitis. The tumor increased in size rapidly and became ulcerated. Three months after the accident the foot had grown to an enormous size and was very painful. An amputation was performed, and on microscopical examination the tumor proved to be a cylindrical-cell carcinoma, the same type as the carcinoma of the rectum.

The history in this case is so precise that it would seem impossible to explain away the causative influence of the trauma on the supposition that there was a pre-existing tumor at the site of the injury. This adds one more to the rapidly increasing list of cases which, following the suggestion of the English surgeons, may be classed as *acute traumatic malignancy*.

The foregoing case closely resembles one reported by one of us (W B C) in 1912, except for the important fact that in our case there was no long "period of latency" between the development of the primary tumor and the metastatic tumor, as a matter of fact, the latter was discovered before the primary tumor had been recognized by any one. The patient, a boy aged six years, was admitted to the Hospital for Ruptured and Crippled on February 20, 1910, as an ordinary case of left inguinal hernia. Operation disclosed an uncomplicated left inguinal hernia which was closed by the Bassini method. The wound healed by primary union and the patient was discharged at the end of three weeks. Seven weeks later he was readmitted with a large swelling in the inguinal region directly under the hernial incision, extending from the anterior superior spine to the upper scrotum, not involving the testicle. The swelling was entirely painless. It was first noticed the week previously by the family physician who had been called in for what was supposed to be an ulcerated tooth, and who, on learning that the patient had been operated upon for a hernia, of his own accord examined the scar and found the swelling described.

On readmission examination showed a fusiform, sausage-shaped swelling, beneath the skin, extending the entire length of the hernial incision. The first impression was that we were dealing with some inflammatory exudate, but there was no fluctuation nor tenderness on pressure, no pain, and no temperature. The skin was normal in appearance. In consistence the swelling was firm but not hard, and from the clinical features, particularly from the "feel" of it, a diagnosis of sarcoma was made by one of us (W B C).

On further questioning it was learned that the patient had had two teeth extracted the week previously because of ulceration. No one had suggested that the condition of the mouth might be due to a neoplasm and not inflammation. On carefully examining the jaw it seemed to me (W B C) quite evident that we were dealing with a malignant, not an inflammatory, condition, and that in all probability this malignant tumor of the jaw antedated the tumor of the groin and had probably been present at the time of the operation although not sufficiently advanced to give rise to any symptoms. Sections from the tumor of the jaw and from the groin were examined by Doctor Ewing, who pronounced both to be round-cell sarcoma. The tumor proved to be a highly malignant

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one After a very brief course of toxin treatment, or two weeks after his entry, the patient was removed from the hospital because of family troubles. Even in this short time the disease had advanced with great rapidity, especially the tumor of the jaw, which had extended up in the orbit almost completely closing the eye. At the same time the glands of the groin and iliac fossa had become involved. The patient died three months from the time the jaw tumor was discovered.

While this is apparently an unique case little if any reference to it has been made in any of the literature on the subject. The most rational explanation of this case is that some of the cells of the unrecognized tumor of the jaw, carrying with them in their nuclei the unknown microbic agent, entered the circulation, but caused no metastases until the local resisting power of the normal body cells was lowered by the trauma of the hernia operation a few weeks before. As a result of this trauma, the exudate and the slight hæmorrhage associated with the operation, furnished just the soil suitable for the development of the organism, hence the rapid development of the metastatic tumors.



FIG 1—Carcinoma of tissues over sternum developing two weeks after severe blow (See Case I)

The following case we believe represents the most convincing example of *acute traumatic malignancy* in carcinoma that has ever been reported.

CASE I—A K., male, aged fifty-nine years, who, while performing his duties as a watchman on November 6, 1931, fell downstairs, receiving a severe blow over the upper part of his sternum from a metal clock that he was carrying. About two weeks later (Fig 1) a small purplish area appeared in the upper portion of the sternum at the exact site of the injury. This soon began to increase in size and became protuberant. It grew very rapidly, and in the latter part of December, 1931, the patient was admitted to Fordham Hospital. An aspiration needle was introduced into the tumor several times in the belief that it might be an abscess. On January 13, 1932, the patient was referred to Dr. William B. Colcy.

Physical examination at this time showed a mass the size of half an orange situated over the upper portion of the sternum, extending above the sternum, and infringing on

the neck over the thyroid gland. It was about three and one-half inches in diameter, and elevated two inches above the normal surface of the sternum. It was purplish-red in color. There were several areas slightly ulcerated and discharging at the site of the previous aspirations. The tumor was firm in consistence over the larger portion—in fact, it was markedly indurated and characteristic of a carcinoma rather than a sarcoma. It was ulcerated over the most protuberant portion, and softer, almost semi-fluctuating over some areas. There were a number of outlying glands along the cervical region, and marked enlargement of the glands in the left axilla. Some of the latter had reached the size of an English walnut, were hard, and typically carcinomatous in character.

The patient was admitted to the Memorial Hospital January 15, 1932, where an aspiration biopsy was performed, and the clinical diagnosis of carcinoma was confirmed microscopically by Doctor Stewart. The condition was so far advanced that it was regarded as hopeless by all who saw the patient. Rontgen therapy had no effect in checking the progress of the disease. Pulmonary metastasis developed in a few weeks and the patient died on February 18, 1932. The entire duration of the disease from the time of the injury until death was only a little over three months.

In this case it was difficult to reach any other conclusion than that the single local trauma was the exciting cause of the disease\*.

In another case, a man while working in a machine shop was struck over the malar bone by a piece of metal. A swelling appeared almost immediately, this never subsided but increased rapidly in size. At the time of the patient's admission to the Memorial Hospital, it had reached the size of a goose egg. While it appeared more like an inflammatory condition, operation by one of us (W B C) revealed a malignant tumor. This diagnosis was confirmed by Doctor Ewing. The tumor, which had been removed as completely as possible, recurred promptly, and the patient died within three months.

These two cases, in our opinion, furnish convincing evidence of the occurrence of *acute traumatic malignancy* in carcinoma as well as in sarcoma.

The following case is another interesting and convincing example of *acute traumatic malignancy*. I am indebted to Dr. William L. Watson for the history.

CASE II—D B, female, aged twenty-one months, on February 21, 1933, while playing on the floor, crawled under the gas range. She had difficulty in getting out, and becoming frightened, struck the top of her head against the range. The mother noticed a small abrasion on the scalp, but no bleeding. On the following day while bathing the child she found a small lump at the side of the injury. Five days later, no improvement being noticeable, she took the child to Dr. J. Edgar, of Jersey City. He regarded the lesion as a hematoma and prescribed local applications and gentle massage. He examined the patient again one week later, when the hematoma showed some evidence of softening, but did not advise any treatment. April 6, or forty-three days after the injury, the mother again consulted the doctor, calling his attention to the change in color of the swelling (it had become dark purplish) and to apparent increase in size. He, in consultation with another physician, then made a diagnosis of sarcoma, and referred the patient to the Memorial Hospital April 11, 1933, where she was placed on the service of Doctor Watson.

Examination on admission showed a firm, pale, purplish tumor mass measuring 6 by 5½ by 2½ centimeters, situated in the vortex of the scalp, and involving the skin. Numerous firm, hard subcutaneous nodules ranging in size from 2½ to 3 centimeters were scattered throughout the occipital scalp and neck.

*Provisional diagnosis* (Dr. F. Stewart) Endothelioma of scalp with metastases to both sides of the neck.

*Treatment* Low-voltage X-rays.

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\* At the trial the Insurance Company made no attempt to deny a causal relationship, and the referee awarded full compensation.

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By April 26 the primary tumor had apparently disappeared and the metastatic masses had practically vanished. A roentgenogram taken at this time showed no definite evidence of bone involvement. An aspiration biopsy was performed, and the following microscopical diagnosis made: unclassified round-cell malignant tumor, possibly endothelial myeloma.

In the foregoing case we believe it would be difficult if not impossible to apply Knox's method of reasoning, *ie*, that there must have been a pre-existing tumor at the site of the trauma. Here we have a young child with very little hair on her head, who was bathed daily by her mother. The latter is positive that there was no lump or swelling of any kind prior to the injury. The small lump or hematoma did not develop until the day after the injury and then, instead of subsiding as an ordinary hematoma would be expected to do, it slowly increased in size. Forty-three days later it had reached the size shown in the accompanying illustration (Fig. 2) and had metastasized.



FIG. 2—Highly malignant metastasizing tumor developing a few days after local trauma. Patient now has general metastases. (See Case II.)

Neither do we believe that Knox's method of reasoning could be applied in our Case I, A. K., which in many ways is similar to the preceding case. Here there is every reason to believe that the tissues over the upper sternum were normal until the time of the injury, there was no evidence whatever of a pre-existing tumor. The swelling did not develop until nearly two weeks after the injury, and was then regarded as either an abscess or a hematoma. In this case, as in the preceding, extensive metastases to the glands of the neck developed but in an even shorter period, *ie*, two weeks after the beginning of the tumor and four weeks after the injury.

The question why a single trauma is capable of changing a pre-existing benign tumor of long standing into a malignant tumor, is one that has been

occasionally referred to in monographs and text-books, but we believe the following case is the only one which has come before the courts for adjudication. According to Ewing, a "pre-cancerous condition may be precipitated into a malignant process by injury. Examples are wounds of a psoriatic tongue by the teeth, injuries of the breast altered by chronic mastitis and incomplete surgical removal of indolent ulcers, mucous polyps, fistulous tracts, and benign tumors."

In the following case one of the writers (W B C) testified as a medical expert in July, 1932

CASE III—Multiple malignant tumor apparently caused by single local trauma

W J N, male, aged sixty-two years, August 29, 1931, was injured in an automobile accident. The sedan in which he was riding was crashed into by a bus, the impact being of such force as to push the sedan forward, up a small embankment, and over on its side. The plaintiff, who was sitting beside the driver, was thrown to the left, striking his leg against the gear shift and emergency brake. He suffered a dislocation of the left shoulder, and felt sore and bruised all over, especially over a small tumor, about the size of a hazelnut, situated in the middle of the right leg, which had existed without any appreciable increase in size for fifteen or twenty years. The family physician, Doctor Bloom, who was called in the same evening, examined the shoulder only, no other part of the body. It was not until five or six weeks later that the plaintiff showed his leg to the doctor. He stated that about three or four weeks after the accident he noticed an area of inflammation on the right leg about a quarter or three-eighths of an inch away from the lump. Six or possibly eight weeks after the injury he began to feel intense pain in the lump on his leg. Three months after the accident the lump had grown to the size of a very large hen's egg. This same lump had been noticed by Doctor Bloom three or four years prior to the accident, and in the belief that it was a sebaceous cyst he considered the possibility of a surgical removal. It was normal in color, of fair consistence, and freely movable under the skin. It had remained practically stationary in size during the period of his observation, but examination five or six weeks after the accident showed it to have markedly increased in size. On his advice, it was removed on December 15, 1931.

*Microscopical Diagnosis*—Mixed spindle- and giant-cell sarcoma, malignant

After three or four weeks' X-ray treatment, a second operation was performed in January, 1932, and in April, 1932, the leg was amputated about six inches above the knee.

The controversial question in this case was, whether or not the injury sustained by the plaintiff in the accident was the cause of the sarcoma which developed on his leg and required its amputation. The plaintiff maintained that the growth on his leg had been there for fifteen years, a benign, quiescent nodule, of firm consistence, movable under the skin, and that in all probability it would have remained as such throughout his lifetime but for the intervention of the accident. On the other hand, the defendant claimed that the growth was at the time of the accident and always had been a neurogenic sarcoma, such as it was found to be when the first operation was performed, and that it was not caused by the injury received in the accident.

An eminent pathologist who testified as an expert in behalf of the plaintiff expressed the opinion that the injury or blow received on August 29, 1931, was competent to stir up and make malignant the quiescent nodule on the man's shin. He stated that he had seen two cases of neurogenic sarcoma in which the growth had followed immediately after an injury.

One of the present writers (Dr William B Coley) also testified as an expert in

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behalf of the plaintiff In his opinion the blow on the leg on August 29, 1931, was a competent producing cause of the sarcoma or malignant condition which was found some three or four months later He cited cases of neurogenic sarcoma coming under his own observation, in which a malignant tumor had developed shortly after an injury and at the exact site of the injury, the diagnosis being confirmed by microscopical examination and the fatal termination of the disease He also cited two cases of quiescent pigmented moles which shortly after a local trauma became rapidly growing malignant melanomas

Another eminent pathologist who testified as an expert in behalf of the defendant expressed the opinion that the plaintiff's condition was the natural history of a neurogenic sarcoma The latter, he stated, has its own mode of growth and behaves as it does for causes that are inherent in the original tumor He admitted the possibility of an adequate trauma causing a quiescent tumor to grow more rapidly

Excerpts from Ewing's book on "Neoplastic Diseases" were read, as follows "Mechanical trauma is an important factor in the causation of tumors The predisposing factors take many forms, there may be a benign or a minute malignant tumor in the tissue before the injury

"Second The precancerous condition may be precipitated into a malignant process by injury Examples are wounds of a psoriatic tongue by the teeth, injuries of the breast altered by chronic mastitis, and incomplete surgical removal of indolent ulcers, mucous polyps, fistulous tracts and benign tumors"

The foregoing is sufficient to give the facts of the case and to show the conflicting opinions expressed by the experts After nearly a week of argument the case was submitted to a jury who rendered a verdict of forty thousand dollars in favor of the plaintiff This amount was reduced to twenty-five thousand dollars by the court An appeal from this decision was made and carried before the Appellate Division of the Supreme Court on April 6, 1933 The decision was rendered July 14, 1933, affirming the first decision

*Intrathoracic or Intra-abdominal Tumors*—While it is now very generally admitted that a single local trauma may be an exciting factor in the development of a malignant tumor at or near the external surface of the body, very few are willing to admit such a causal relationship in cases of intrathoracic or intra-abdominal tumor Knox,<sup>6</sup> in her review on trauma and tumors, stated "that serious injuries to the chest are so frequent and pulmonary tumors so rare that, statistically, a causal relationship is not even suggested" On the other hand, Aufiecht<sup>16</sup> regarded severe trauma which "does not produce laceration of the pulmonary tissue, but only molecular disturbances of an unknown character," as an important immediate cause of carcinoma of the lungs He cited four cases personally observed in which the pulmonary carcinoma was preceded by severe trauma These cases were regarded as of sufficient importance for Ewing to refer to them in his book on Neoplastic Diseases (*loc cit*)

In a recently reported case of primary carcinoma of the lung, Wells and Cannon<sup>17</sup> offer what we believe to be most convincing proof of a causal relationship between the carcinoma and the trauma which preceded it This case is briefly as follows

Male, aged fifty years, had always been in good health until September 1, 1926 when he was knocked down by an automobile Severe pain in the chest followed A roentgenogram taken on the next day showed a fracture of the left third, fourth and fifth



ribs in the mid-axillary line. There was also distinct evidence of traumatic injury to the lung, namely, hemoptysis and a subcutaneous emphysema extending over the entire body. No evidence of any neoplasm in the lung was revealed by the roentgenogram. The patient made an uneventful recovery and seemed to be in good health until the following August, when he complained of pain in the left side of the chest. A cough developed, and while symptoms suggestive of pulmonary tuberculosis appeared, no tubercle bacilli could be found in the sputum. Roentgenograms taken at this time revealed evidence of cancer in the left upper lobe of the lung. The clinical course was steadily downward ending in death on August 17, 1928, or one year after the development of symptoms and barely two years after the injury to the left lung.

A *post-mortem examination* made by Doctor Paul R. Cannon revealed the presence of a primary carcinoma of the upper lobe of the left lung, with metastases to the mediastinal and left supraclavicular lymph-nodes, in the retroperitoneal peri-aortic lymph-nodes as far down as the bifurcation in the right suprarenal gland and both kidneys. There was a thickening and an irregularity in the third, fourth and fifth left ribs in their middle thirds from the healed fractures. There were no tumor nodules in the right lung.

*Histological Examination* showed the tumor to be composed of cells which generally appeared elongated, consisting chiefly of nucleus with little cytoplasm, thus much resembling sarcoma cells, but they tended to form alveoli, did not secrete collagen, and often exhibited a palisade arrangement. In no place did the cells exhibit a characteristic epithelial structure, nor did they form tubular structures, secrete mucin, or undergo keratinization. In other words, the structure was that of the type of lung tumors that has often been described in the earlier literature as sarcoma and later as mesothelioma, and which has been interpreted by some as a tumor arising from the flat epithelium of the alveoli.

According to Wells and Cannon, this case "seems to present as nearly completely satisfactory evidence as one can hope to secure of the development of a primary carcinoma of the lung as a direct result of a single traumatism to the lung tissue. Roentgen plates of the chest made immediately after the injury show that at this time there was no evidence of a carcinoma of the lungs demonstrable by this means. There is conclusive evidence of traumatism to the lung (hemoptysis and severe subcutaneous emphysema). The interval between the time at which the traumatism was received and the appearance of symptoms of the cancer of the lung (eleven months) is entirely in harmony with the assumption that the neoplastic growth was caused by the traumatism of the lung, and the duration of life after this time (twelve months) is in keeping with the rate of growth to be expected from a tumor reaching the observed state in the first eleven months after the traumatism.

"Of course, it is not possible to say that there was not already a carcinoma, too small to be detected in the Roentgen film, growing in the part of the lung that was traumatized at the time of the injury. But in view of the extreme infrequency of primary carcinoma of the lung arising in the periphery of the upper lobe, to support such an explanation of this particular case requires a stretching of 'the long arm of coincidence' to the vanishing point."

Personally, one of the writers has observed only one case of intrathoracic tumor in which he was fully convinced that the single trauma experienced was the exciting causative factor of the development of the tumor. This case later became one of the most important medico-legal cases that has ever come before compensation boards in this country. It was reported by Doctor Coley at a meeting of the New York and New England Association of Railway surgeons. In certain respects it closely resembles the case reported by Wells and Cannon.

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CASE IV—L D, aged thirty-six, weight 200 pounds, had always been well until July 30, 1921, when while working, he was caught between scaffold and stone coping of roof, receiving a severe bruise over the ninth, tenth, and eleventh ribs on left side. Felt very sharp pain and great difficulty in breathing, which continued so that he found it impossible to sleep while lying down. Three days after injury, physician was called who found swelling, ecchymosis and tenderness at site of injury. He tried to do light work for two or three weeks, but gradually became worse and coughed up blood, so gave up working. No X-ray taken at time of accident, but six weeks after injury, X-rays showed what was taken to be exudate in pleural cavity at site of injury, and diagnosis of traumatic pleurisy was made. Patient grew rapidly worse and died, January, 1922. Full course of disease less than five months. Autopsy showed malignant tumor involving ninth, tenth, and eleventh ribs at exact site of injury, also tumor of left lung, tumor of right lung and liver. Microscopical examination by Doctor Ewing epidermoid carcinoma.

During period of five years case came before four referees. Attorney for plaintiff (widow), claimed injury was competent producing cause of death. Attorney for defendant (Insurance Company, carrier), claimed cancer was primary in lung for considerable period before injury, and that injury had no causal relationship with tumor, nor did it in any way accelerate condition.

First trial. Verdict in favor of defendant.

Second trial. Lasted a year, due to various postponements, referee went out of office.

Third trial. Case reheard from beginning. Expert for defendant, pathologist of great experience, testified that histological type of tumor, epidermoid carcinoma, ruled out possibility of its originating in ribs or tissues about site of injury. One of writers (W B C), testifying as expert for plaintiff, expressed opinion that all clinical facts of case, pointed to tumor being primary at site of injury, not at root of lung, he believed tumor at root of lung to be metastatic from tumor at site of injury. This clinical evidence, he believed, outweighed that based solely on the histological type of tumor, for the reason that tumors of the lung are recognized as extremely difficult to classify exactly, some pathologists calling a case epidermoid carcinoma and other endothelioma. Verdict of third referee in favor of defendant.

Fourth trial. Plea to have case reopened granted by Hon Frances Perkins, now U S Secretary of Labor, who had succeeded referee who made last decision. Case again heard in fall of 1927, and in July, 1928, final verdict was rendered by Commissioner Perkins in favor of plaintiff, reversing the previous decisions. A copy of her decision may be of interest.

"Because the question of fact in this case was considered to be extremely close, the record has been personally reviewed by four members of the Board, each reading independently and writing a memorandum of decision without conference with the others. The only question involved is that of causal relation between the accidental injury and the death of L D.

"Three members of the Board have found causal relationship to be established and one considers the weight of medical evidence to be against such a finding. The Board, therefore, finds that L D sustained a crushing injury to his chest wall on July 30, 1921, that the injury was serious is shown by the fact that he had difficulty in breathing and continuous pain in his chest for many weeks. In September, 1921, he had a hemorrhage and spat blood and pus. The pus when analyzed showed streptococcus and staphylococcus.

"There can be no doubt of the inflammatory condition or that it resulted from the accident. This indicates serious injury to the pleura. The case was diagnosed by his physician as traumatic pleurisy. He grew constantly worse, was in a hospital for sev-

eral months, treated for pleurisy, broncho-pneumonia with some physicians suspecting tuberculosis. He had been a man in exceptionally good health prior to the accident but he declined rapidly. On January 11 1922 he died, still a puzzle to the hospital physicians. An autopsy was performed and an epidermoid carcinoma was found to have involved the lungs, ribs, kidney and liver. This carcinoma is stated to be the cause of death.

"The contest has been as to whether there was a causal relationship between the injury and this cancerous growth which progressed so far as to cause death. The testimony on this point has been difficult to follow because obscured at times by antagonisms and by arguments and confused by objections, interruptions and comments by counsel for both sides to a degree at least unusual in this jurisdiction. His family physician who treated him throughout as of the opinion that death was the result of the accident. There is also other expert medical testimony to this effect.

"After long and careful consideration, the Industrial Board finds that the death resulted naturally and inevitably from the accidental injury."

In reporting this case (see 1929 Year Book, New York and New England Association of Railway Surgeons) Doctor Coley cited two other cases in which very similar verdicts had been rendered by the Supreme Court\*. In the first, the referee ruled that "compensation is payable where death occurs within 300 weeks of the time of the accident, provided the testimony shows it was caused by the injury, or, by reason thereof, an incipient condition was hastened to development, ending in the loss."

In the second case it was ruled that "claimants'" right to recover compensation is controlled by section 2 subdivision (d), of the Workman's Compensation Act (Law 1918, c 400), which is as follows

"'Injury' and 'personal injury' shall mean only injury by accident arising out of and in the course of the employment and shall not include a disease in any form, except where it results naturally and unavoidably from the accident.

"It is conceded that if there is evidence to sustain the finding that the sarcoma resulted from the alleged injury, or if it was at the time of the accident in a quiescent state and the accident aggravated it and hastened the employee's death, then the requirements of the above-quoted section are met and the present claimants are entitled to compensation."

*The referee continued as follows*

"Whatever view we take of the medical opinion, they are frankly and at best but theories, but taking them as they are in connection with the facts heretofore narrated and taking a common-sense, practical view, as courts and commissions must take of the ordinary happenings of life boiled down to its last analysis, the medical theory is that there is a relationship between the receipt of injury and origin of sarcoma, and that the degree of injury plays no important part. With this in mind we find a perfectly healthy, strong man, who has never lost any time from work or complained of any illness suffers an injury and from that time on is incapacitated, grows worse and worse, sarcoma develops at the point of injury, from which he dies. The lay mind, under such

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\* *Smith vs Primrose Tapestry Co*, 131 Atl Rep 703 (285 Pa 145), decided by the Supreme Court Pennsylvania January 4 1926. *Winchester Milling Corporation et al V Sencindiver et al* 138 S E Rep 479, Supreme Court of Appeals of Virginia June 16, 1927

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circumstances, can reach no other conclusion than that reached by the commission, *viz.*, that the sarcoma was either caused by the injury or was aggravated by it

"To this we may add that the courts have in general found no difficulty in cases similar to the one we are considering here, in applying the ordinary rules of evidence, and in drawing the ordinary conclusions of cause and effect from established facts, and we find none. This, we doubt not, courts will continue to do with a full sense of justification and without apology until the cause of cancer is definitely and scientifically established"

In the following case of intra-abdominal sarcoma following a recent trauma the evidence of a causal relationship appears to be convincing

CASE V—R. T., male, aged thirty-four years, had always been in good health until July 3, 1916, when he fell from a building for a distance of eighteen feet striking on a cement floor, he landed in such a position that his upper abdomen received a sharp blow from his doubled-up elbow. Six or seven months later he complained of pain in the upper left abdomen at the site of the injury. He consulted a number of physicians and surgeons who made various diagnosis. In December, 1917, he came under the care of Doctor Charles H. Mayo, who made a clinical diagnosis of lymphosarcoma of the small intestine. He performed an exploratory operation which revealed a large, inoperable tumor of the mesentery and small intestine, largely posterior to the parietal peritoneum. Deeming a surgical removal unwise, Doctor Mayo referred the patient to us for conservative treatment. Under irradiation and toxins the tumor practically disappeared, and the disease was held under control for five or six years at the end of which time metastases developed in the neck and axilla. Under further treatment the disease was again controlled. At the end of nine years the patient had a recurrence of the original tumor and died in a few months. The microscopical diagnosis in this case was lymphosarcoma. Autopsy was performed, and the only tumor found in the entire body was at the site of the original tumor.

*Trauma and Its Relationship to Tumors of the Testicle*—Most writers on tumors of the testicle, having observed a large number of cases in which there was a history of antecedent local trauma, have come to the conclusion that there is a causal relationship between trauma and tumor formation. Dew,<sup>18</sup> in his book on "Malignant Disease of the Testicle," states

"The testicle from its exposed situation is particularly prone to traumatic insults, and as it is peculiarly sensitive these are often keenly remembered, yet neoplasms of the testicle are quite rare. Still even bearing in mind the very human tendency which seeks to attribute disease to a definite cause such as injury, all statistics go to show that, in this organ, trauma is an important factor, and most writers on the subject emphasize its importance.

"In a carefully recorded series Howard<sup>19</sup> found that eight cases out of twenty-seven gave a history of recent trauma and in another case there was a history of trauma some time before. Miyata,<sup>20</sup> out of twenty cases, found trauma a factor in ten. Sehaguchi reported four out of thirty-two to give a definite history of injury. O'Crowley<sup>21</sup> reported six cases out of a series of thirteen. In the present series I have found that out of the thirty-three of which clinical notes are available, twelve gave a history of more or less recent trauma.

"Practically all observers give similar figures.

"It is extremely difficult to be sure that a definite essential connexion between tumour formation and trauma does exist, but the figures strongly favour that belief. It is well known that, experimentally, trauma has the power of exciting spontaneous growth in ova

parthenogenetically and it may be that investigation along these lines will provide an explanation

"There is no doubt that the opinion of experienced observers may be summed up by stating that there is a definite history of trauma in anything up to 50 per cent of these tumours, though definite causal relationship still remains to be proved"

According to Ophuls, carcinoma of the testicle is the only type of carcinoma which is frequently caused by a single, more or less severe injury. He states "This includes the so-called round-celled sarcoma of this organ, because careful histological examination reveals that most of these so-called sarcomata arise from the epithelium of the seminiferous tubules, and therefore should be classified as carcinomata. The frequency of their traumatic origin, to my mind, has not been sufficiently emphasized, but anyone who has had experience with these growths will readily confirm it from personal experience, and a study of the case reports collected in literature reveals the same thing. When we consider the constant and very active multiplication of the spermatogenous cells under normal conditions, we may readily understand why a thorough, even single disturbance of them may lead to such disastrous consequences. The mere fact that these growths are usually encountered in comparatively young individuals, in the prime of sexual activity, lends strong support to this theory. It would appear, then, that in estimating the probability of a connection between trauma and the development of a true tumor, the collective experience so far obtained in the particular type of tumor concerned should also be carefully taken into account"

In a monograph on "Malignancy of the Testis, with Special Reference to Undescended Testis" (Minneapolis Surgical Society Prize Winning Essay for 1930), Rea<sup>22</sup> reports seventy-six cases of malignant tumor of the testis. In discussing etiology, Rea<sup>22</sup> states "Twenty-nine of the patients (38 per cent) gave a history of some variety of trauma preceding the recognition of the tumor, but the information in the records is of such a character as to leave much doubt as to whether the trauma had actually any significance in the development of the lesion or whether it served merely to call attention to a pre-existing tumor"

Kober<sup>23</sup> found a history of trauma in 28 per cent of 114 cases

One of the writers (W. B. C.), in a study of sixty-four cases of sarcoma of the testis personally observed up to 1914, found a definite history of antecedent trauma in 33 per cent

*Melanotic Sarcoma*—While the majority of melanomas or melanotic sarcomas have their origin in a pigmented mole, the transformation of the latter into a malignant tumor is usually associated with repeated trauma or repeated irritation, for example, friction from clothing or from a bath-towel. Many cases, however, give a history of a single local trauma, such as, tying off a pigmented mole with a silk ligature, the use of cautery or some form of caustic. One striking example in our experience of a melanoma developing from a single trauma occurred in an Army man who, in 1917, received a typhoid inoculation through a small pigmented mole in the deltoid region. This had existed since childhood. Within a few weeks the mole showed evidence of increasing activity, it grew rapidly in size, and in spite of a surgical removal, the disease metastasized to the glands proving fatal in less than a year.

*Neurogenic Sarcoma*—The statement has been made at medico-legal trials that neurogenic sarcoma is practically never associated with antecedent trauma. This has not been borne out by our personal experience. We have

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observed a number of cases of neurogenic sarcoma in which there was a very definite history of local trauma. For example, a woman while travelling on an ocean liner was struck in the middle of the forearm by the heavy wooden cover of a wash bowl. There was a definite bruise but no swelling at the time. A few months later, a swelling developed at the exact site of the injury. A local removal was made, followed later by an intrascapulo-thoracic amputation. The disease metastasized to the lung, proving fatal within a year.

An analysis of seventy-two cases of neurogenic sarcoma by Quick and Cutler<sup>24</sup> shows a history of trauma in fourteen, or 19.3 per cent.

CONCLUSIONS —A careful study of our own series of cases personally observed, we believe, warrants the following conclusions:

(1) That a single local trauma may be an important factor, probably the determining factor, in the development of malignant tumors of all types.

(2) That trauma is a causative factor in a larger proportion of cases of sarcoma than carcinoma, and in a larger proportion of bone sarcomas than soft-part sarcomas.

(3) That the interval of time elapsing between the injury and the appearance of the tumor is often much shorter than is recognized by most writers. In the majority of cases the tumor develops within the first month or six weeks of the injury but in a considerable number of cases it may develop within one or two weeks. The latter cases justify the classification of *acute traumatic malignancy* originally suggested by the English surgeons. The examples herein reported furnish convincing evidence of the actuality of such a condition.

(4) While courts and compensation bureaus both in this country and in Europe have very generally recognized single trauma as a competent producing cause of all types of malignant tumors, it is only fair to the insurance carriers that each case be studied and judged on its own merits.

(5) If the case in question fulfills all the conditions laid down by Segond then a causal relationship between the injury and the tumor must be admitted.

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# SURGICAL OPERATIONS IN ADDISON'S DISEASE

## SUCCESSFUL EPIDIDYMECTOMY AND ORCHIDECTOMY FOR TUBERCULOSIS

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A PATIENT with Addison's disease requires protection from every outside influence which will increase the demand on his slender reserves of strength. Undue fatigue, extremes of heat or cold, and mental or emotional strains are all to be avoided. The increased susceptibility to infection and the frequency with which fatal termination of the disease are initiated by intercurrent infections such as colds, sore throat, or influenza are well recognized. It is not surprising therefore, as pointed out by Rowntree and Snell,<sup>4</sup> in 1929, that these patients are extremely bad risks from the surgical point of view. We have observed fourteen cases in which surgical procedures have been attempted in patients with Addison's disease (Table I). In eleven of these cases the shock of operation precipitated an attack of acute suprarenal insufficiency with crisis and death from one to sixteen days later. Six of these patients presented themselves to the surgeon because of tuberculosis of the genito-urinary tract. In only one was the possibility of Addison's disease suspected prior to operation but in all extensive and previously unsuspected caseous tuberculosis of both suprarenal glands was found at necropsy. Apparently it is of the greatest clinical importance to consider fully the possibility of suprarenal tuberculosis with latent Addison's disease as a complication among patients who present themselves for the surgical treatment of tuberculosis of the genito-urinary tract.

In the last two years we have had the opportunity to treat thirty-two patients with Addison's disease with the cortical hormone of the suprarenal gland prepared by the method of Swingle and Pfiffner<sup>5 6 7, 8</sup>. This experience has convinced us of the efficiency of this preparation in combating crises of acute suprarenal insufficiency and the effects of acute streptococcal sore throat in such cases. Besides the treatment of the general condition, which resulted in improvement, several of these patients have had teeth extracted, one had a minor nasal operation and another a plastic operation on the eyelid while under treatment with the cortical hormone. These minor operations caused no more discomfort or reaction than they would if the patients had been in normal health, a striking contrast to the severe reactions which usually characterize such procedures in untreated cases of Addison's disease. The effect of treatment in these cases justified its trial in a more serious surgical condition.



TABLE I  
*Results of Operation*

Case	Age Years and Sex	Asthæ- nia Grade	Pigmen- tation Grade	Blood pres- sure mm of Mercury		Operation	Comment	Necropsy Data
				Sys- tolic	Dias- tolic			
1	34 M	2	1			Amputation of right leg	Death in three days	Bilateral tuberculosis of suprarenal glands
2	46 M	2	2	108	78	Cholecystec- tomy	Death in one day	Bilateral tuberculosis of suprarenal glands
3	37 M	1 to 2	1 to 2	130	90	Thyroidectomy	Death in three days	Atrophy of suprarenal glands
4	40 F	0	0	140	60	Hysterectomy	Death in three days	Atrophy of suprarenal glands
5	32 M	0 to 1	1 (racial)	105	75	Hæmorrhoidec- tomy	Death in four days	Bilateral tuberculosis of suprarenal glands
6	65 M	1	1	110	78	Nephrectomy	Death in one day	Bilateral tuberculosis of suprarenal glands
7	26 M	1 to 2	2	105	75	Nephrectomy	Death in three days	Bilateral tuberculosis of suprarenal glands
8	32 F	3	2	75	?	Nephrectomy	Death in two days	Bilateral tuberculosis of suprarenal glands
9	M	1	0			Cystostomy	Death in three days	Bilateral tuberculosis of suprarenal glands
10	25 M	2	1 to 2	100	80	Orchidectomy	Death in seven days	Bilateral tuberculosis of suprarenal glands
11	30 M	2 to 3	1	106	66	Bilateral epi- didymectomy	Death in six- teen days	Bilateral tuberculosis of suprarenal glands
12	54 F	2	3	80	60	Drainage of lumbar abscess	Survived Ad- dison's disease	
13	52 M	2	2	100	75	Excision of cer- vical lymph- nodes	Survived Ad- dison's disease	
14	54 F	2	2	90	70	Tonsillectomy	Survived Ad- dison's disease	

REPORT OF CASE—A man, aged thirty-two years, came to The Mayo Clinic, April 29, 1931, because of a generalized brownish pigmentation of the skin which had first been noted following an attack of influenza three years before. Apart from the color of the skin he had been well and active, and had not lost weight or strength. Examination showed a diffuse brown pigmentation of the skin with intensification over the scrotum and perineum. There were a few black freckles scattered over the face and neck. The lips were dark, but the buccal mucosa was not pigmented. The blood-pressure in millimetres of mercury varied from 98 to 134 systolic and from 68 to 80 diastolic.

## TREATMENT OF ADDISON'S DISEASE

Apart from marked chronic prostatitis, the results of examination were negative. No evidence of tuberculosis was found on general examination, by roentgenograms of the thorax and suprarenal area or by search of the sputum, urine or stools. A diagnosis of probable Addison's disease was made on the basis of the pigmentation. The patient was advised to conserve his strength and was placed on a Muirhead regimen by way of protection and treatment. Treatment for the prostatitis was also ordered.

The patient returned to the clinic January 8, 1932, because of acute left epididymitis which had developed two days before. Apart from the epididymitis his general condition was the same as the year before. No further evidence of active tuberculosis could be found. The acute inflammatory manifestations of the epididymitis at first subsided under conservative treatment, with rest, hot applications, and calcium gluconate, but

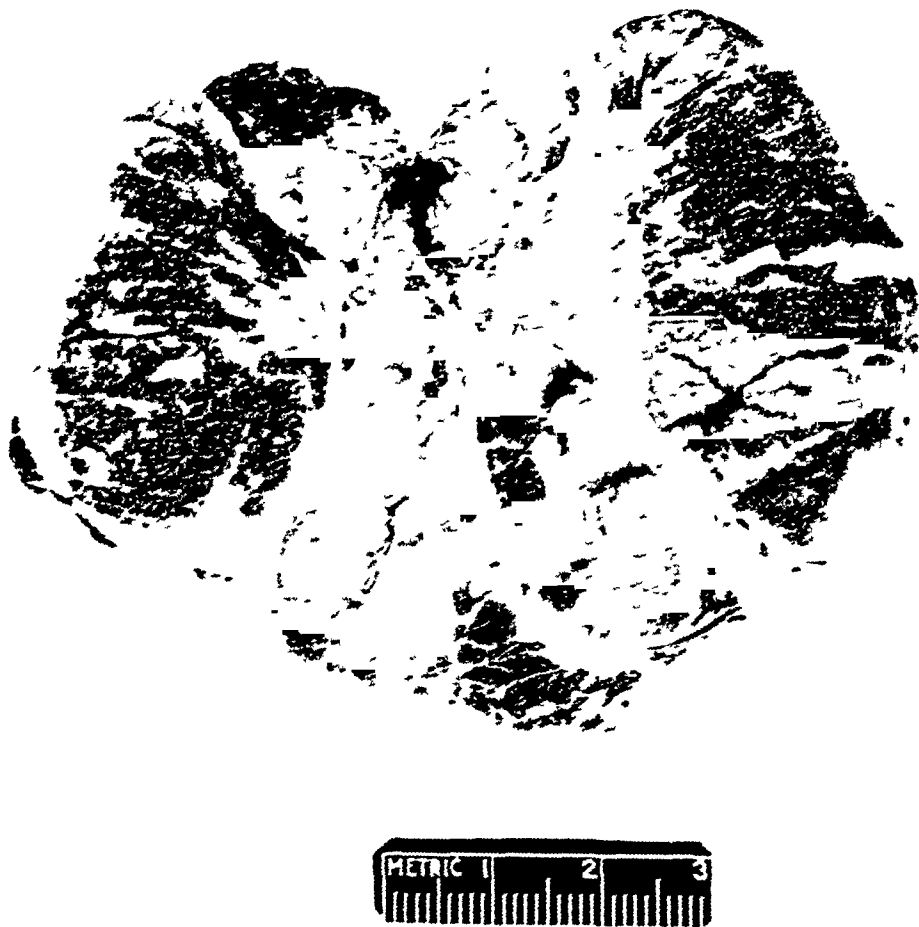


FIG. 1.—Tuberculosis of the epididymis with slight involvement of the testis

later recurred. February 1, acute left hydrocele also developed. In consequence of this it was felt that the lesion was probably tuberculous and that operation was indicated. A pre-operative course of treatment with the suprarenal cortical hormone (Eschatin, Parke, Davis and Company) was decided on. The patient was given forty cubic centimetres in divided doses intravenously during the two days preceding operation.

At operation, February 9, which was done under local anaesthesia, it was found that the left testis was enlarged to about twice normal size, due to enlargement and partial destruction of the epididymis by multiple tuberculous abscesses. The inflammation appeared to extend into the testis and rather than take the risk of failing to remove all of the areas of infection as well as to avoid the effects of absorption from an infected area in the testis, it seemed safer to remove the testis with the epididymis. This was done through a scrotal incision. The pathologist reported tuberculosis of the epididymis with slight involvement of the testis (Figs. 1, 2 and 3).

Immediately after the operation the patient was given twenty cubic centimetres of the



FIG 2



FIG 3

FIG 2—Tuberculosis of the epididymis with caseation ( $\times 60$ )  
 FIG 3—Tuberculosis of the testis with caseation ( $\times 60$ )

cortical hormone He had a comfortable night and the next day two injections of ten cubic centimetres each were given Subsequent injections were given at longer intervals, the total amount being 110 cubic centimetres As shown in Fig 4, the post-operative

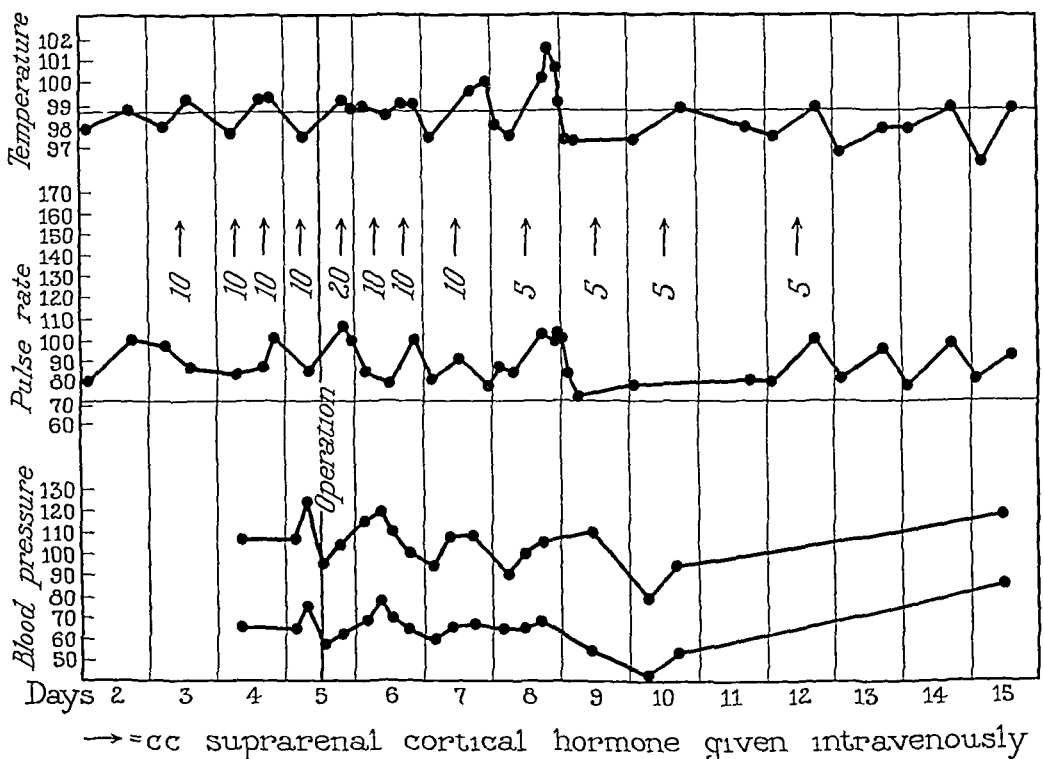


FIG 4—Temperature pulse rate and blood pressure readings before and after operation Arrows indicate intravenous injections of the suprarrenal cortical hormone

## TREATMENT OF ADDISON'S DISEASE

course was entirely uneventful. The blood-pressure never fell below 90 systolic, varying between that and 125 with a pressure of 50 to 78 diastolic. He was dismissed from the hospital February 24 in good condition and is now back at work\*.

When the patient was first seen, a diagnosis of probable Addison's disease was made. Observation over a period of nine months together with the demonstration at operation of active tuberculosis of the genito-urinary tract, we believe, has now established the diagnosis of Addison's disease beyond any reasonable doubt.

We have been unable to find in the literature record of a successful major operation on a patient with unquestioned Addison's disease. Oestreich,<sup>3</sup> Bartels,<sup>1</sup> and Heinlein<sup>2</sup> each have reported the removal at operation of a single caseous suprarenal gland, but in none of these cases was their clinical signs of suprarenal insufficiency and the presumption that the destruction of the suprarenal gland was primarily unilateral is likely.

This case is unique in that, so far as we know, it is the first one in which pre-operative and post-operative treatments with the cortical hormone have been used to protect the patient against the shock of operation, and the only case of Addison's disease, to our knowledge, in which the patient survived such an operation.

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\* The patient returned to the clinic September 15, 1932, for reexamination. He was in excellent condition, had gained in weight and the pigmentation of his skin did not appear as marked as on his previous visit.

## SPONTANEOUS PNEUMOTHORAX\*

BY GEORGE P MULLER, M D , AND FRANCESCO MOGAVERO, M D  
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CASE I—A man, aged twenty-five years, by occupation a law clerk, was admitted January 8, 1930, to the Misericordia Hospital in the service of Dr George P Muller, with the diagnosis of acute mesenteric ileus or chronic appendicitis His chief complaint was severe upper abdominal pain The patient was awakened in the early morning with severe sharp stabbing pain in the epigastrium which was not referred and which doubled him up He had normal bowel movement, but obtained no relief from pain Shortly afterwards, he had a copious watery bowel movement, but still with no relief from pain The pain became worse and he called a physician, who gave him morphine hypodermically, but without relief He was nauseated but did not vomit The family physician stated that the abdomen was rigid and tender and from this clinical picture he made a diagnosis of ruptured peptic ulcer and sent him immediately to the hospital

*Physical Examination*—Blood-pressure, 130 S, 75 D Temperature, 96.3, pulse, 126, and respirations, 40 The patient was suffering agonizing pain, his skin was cold and clammy, but he had no dyspnoea or cyanosis On examination of the chest, expansion was free and equal, no respiratory embarrassment, tactile fremitus normal, percussion note resonant throughout and breath sounds vesicular Heart No murmurs or arrhythmia Sounds of good quality Pulse Rapid, of good volume and rhythm

Abdominal examination was negative, except for board-like rigidity and extreme tenderness in epigastrium

Pre-operative diagnosis Ruptured gastric ulcer

Immediate operation was performed under spinal anaesthesia Spinocaine, four cubic centimetres, was given, but the abdomen still showed board-like rigidity although he did not feel any pain Anaesthesia was re-enforced with ether

On opening the peritoneum no free fluid was encountered The stomach was found greatly dilated, but revealed no evidence of ulcer or of perforation The entire abdominal cavity was explored, but no cause for his symptoms was discovered A gastrotomy was performed to empty the dilated stomach of gas The gastric opening was then closed The caecum was located and delivered and a chronically diseased appendix removed The abdominal wound was closed without drainage The patient left the operating room in good condition

*Post-Operative Convalescence*—Twelve hours after operation, the patient became dyspnoeic with shallow respirations He was cyanotic, felt that he was suffocating, and complained of pain in his left scapula He was cold, clammy, restless, and at times irrational Examination of chest showed that the left side was fixed, the intercostal spaces were slightly bulging, the percussion note was tympanic and the heart was pushed to the right The abdomen was soft but not distended A diagnosis of left spontaneous pneumothorax was made An X-ray was taken immediately which confirmed the diagnosis

The patient was desperately ill and immediate aspiration of the chest was instituted The cyanosis became less, the pulse of better quality and the rate slower

	Before Aspiration	After Aspiration	24 Hours Later
Pulse Rate	140	120	90
Temperature	101° F		99° F
Respirations	46	40	28

\* Read before the Philadelphia Academy of Surgery, December 5, 1932

## SPONTANEOUS PNEUMOTHORAX

The patient made an uneventful recovery, although at the time of discharge he still showed signs of pneumothorax with some displacement of the heart

*Progress Notes Since Discharge from Hospital*—After the patient's discharge from the hospital, he felt well, had no dyspnoea, and X-ray examination of chest for comparative study with previous films showed the pneumothorax with collapse on the left side to have entirely disappeared. The entire right pulmonary field showed a slight mottling throughout. This had not the characteristic appearance of tuberculous infection, but rather that most often produced by an influenzal infection, or secondary to upper respiratory disease. About two weeks later, he complained of some dyspnoea and tired feeling, and was admitted to the hospital of the University of Pennsylvania for study on March 3, where it was stated that a recurrence of the pneumothorax had occurred.

Since then there has been no recurrence of the pneumothorax.

The speaker remarked that spontaneous pneumothorax of the complete type is rarely seen in an individual who does not show any evidence of intrathoracic disease. It was best defined by Hammon as a "pneumothorax coming on in an apparently healthy individual without any ascribable cause, resulting in no infection of the pleura and therefore unaccompanied by constitutional symptoms and healing rapidly and completely in a few weeks." The existence of it has been known for years. Hippocrates called it empyema, and it was again brought to medical attention by Meckel in 1759, in 1803, Ward gave it a definite name, Laennec in 1819 described a case, and Zahn in 1891 published the first full satisfactory report.

The onset of pneumothorax may be insidious, slow leak, or acute, the acute causing respiratory embarrassment. The description of the physical and clinical signs can be found in any text-book of medicine. Kahn<sup>6</sup> states that a small pneumothorax containing only 200 to 500 cubic centimetres is practically undetectable by physical examination, and one of 200 to 250 cubic centimetres even by Rontgen examination. This he has verified by examination after initial introduction of air in artificial pneumothorax therapy.

Pneumothorax is further divided into tuberculous and non-tuberculous or idiopathic types, for which no set cause can be found.

Weber<sup>5</sup> gives a review of causes of idiopathic, believing some due to rupture of emphysematous bleb in the margin of the lung, and some due to inflammatory condition causing adhesions between the visceral and parietal pleura, and that some unusual exertion causes adhesions to be torn loose, thus causing a rupture, the exciting causes being coughing, sneezing, laughing, vomiting, hiccough, muscular strain. Further, some may occur during sleep. Wood and Vinson<sup>4</sup> report one due to forced deglutition occurring in a case of obstruction of the cardiac end of the stomach.

Other causes, but not idiopathic, are abscess, Browder<sup>14</sup> reports a case following rupture of subpleural abscess, gangrene and new growths of lung, bronchiectasis, emphysema, tuberculosis, empyæma and pneumonia, accidental pneumothorax following fracture of ribs. Harvey<sup>16</sup> reports a case.

Weber<sup>5</sup> believes that all cases are due to healed miliary tubercle, rupture

of minute superficial emphysematous bulla, just below the visceral pleura, that the difference between idiopathic and tuberculous spontaneous pneumothorax is that the latter are connected with still more or less virulent tuberculous foci containing living organisms, whereas the latter are connected with healed non-virulent sterile lesions

Heischboeck<sup>11</sup> does not believe that tuberculosis always causes the small bleb, but that other lesions can cause it. Burrell<sup>8</sup> noted in his work that in spontaneous idiopathic pneumothorax pleural effusion does not occur, and in a large series of cases in which artificial pneumothorax is produced that effusion occurs in tuberculosis cases and not in the non-tuberculous cases and that this can be used as a diagnostic point. Kahn<sup>6</sup> gives the types of pneumothorax with treatment and divided thus

(1) *Closed type*, in which there is little or no respiratory distress. These cases do best if left alone, and the air will be absorbed.

(2) *Closed pneumothorax* with symptoms of respiratory distress. In these, aspiration of air should be carried out.

(3) *Closed pneumothorax* with effusion. The treatment is expectant. Aspirated for study of the fluid and air drainage instituted if necessary.

(4) *Valvular pneumothorax*.—These are, as a rule, fatal. The treatment of this type of case is by continuous air drainage through a needle with rubber tube passing to some fluid container (closed drainage). Pyothorax usually occurs.

(5) *Open pneumothorax*.—In these cases, as pyothorax occurs, postural drainage should be instituted.

In review of cases by Heischboeck, he noted that the occurrence of spontaneous pneumothorax occurred between the ages of fifteen and forty-five. Nikolsky stated that in 80 per cent of cases, males are affected, and it occurs with equal frequency on both sides of the chest, though individual statistics vary on this point. Palmer and Taft<sup>2</sup> showed that tuberculosis in adults caused 80 to 90 per cent of the cases in adults, and 40 to 50 per cent in children.

The duration of the pneumothorax in the uncomplicated cases is, as a rule, from two weeks to two months, however, it can last longer. Heischboeck reports a case of eleven years' duration, Wieler, one of twenty years, LeWald,<sup>13</sup> one of ten years, and another of one year.

Spontaneous pneumothorax can recur. Watson and Robertson<sup>12</sup> report three cases.

Biach reported 918 cases of spontaneous pneumothorax, but 715 were proved to be tuberculous, and 200 cases were idiopathic. Fussell and Reisman reported fifty-eight cases with one death. Biesenthal and Snyder,<sup>3</sup> in 1932, reported 200 cases on record and added twelve cases of their own.

In going over the literature, spontaneous pneumothorax of idiopathic division is not uncommon.

## SPONTANEOUS PNEUMOTHORAX

It was interesting to note that Heischboeck reports fifteen cases of bilateral pneumothorax with recovery, however, many cases of bilateral pneumothorax nearly always prove fatal, the patient dying in a few hours

In reference to treatment That of Kahn has already been given Stewart<sup>1</sup> advised tapping of chest and leaving needle *in situ* In one case, he let the needle remain for three weeks Biesenthal and Snyder advise rest in bed for a period from four to six weeks By the end of that time, the lung will re-expand In one of his cases re-expansion of lung did not occur after four months, and he hastened the expansion of lung by use of blowing in bottles Weber believes that all get well without specific treatment Tilton and Schroeder<sup>7</sup> advise immediate aspiration in cases showing acute symptoms Burrell<sup>8</sup> states in cases of few symptoms, the lung usually re-expands in a few days and a period of rest is all that is required If the symptoms persist remove gas in order to assist re-expansion and stop if patient coughs If pressure is lowered too quickly, the patient develops paroxysms of cough with frothy expectoration and very severe dyspnoea lasting several days

Fogelberg,<sup>9</sup> in 1924, had two cases in which he hastened re-expansion by Spengler's method of interpleural injection of 30 per cent solution of glucose This method is to be used only in spontaneous pneumothorax without effusion

The following is a case report of acute spontaneous pneumothorax which simulated acute upper abdominal lesion This case is reported not so much because of the rarity of the occurrence of cases of this kind, but because of the error in diagnosis which led to a major operation

This case is interesting because it seems probable that the first rupture with escape of air filling the mediastinal tissues and through contact with the nerve supply gave the intense symptoms of referred upper abdominal pain Later, the rupture into the pleural cavity occurred with the development of pneumothorax It is also interesting to note that at the time of the first pneumothorax the patient's symptoms were intense and particularly he had the fear of impending death Two and one-half months later, when he had his second attack, he was conscious only of pressure, but otherwise was not disturbed Since that time, two and one-half years, he has not had a recurrence

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# LATERAL ABERRANT THYROID GLANDS

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SHRAGER,<sup>1</sup> in 1906, defined an aberrant thyroid as a mass of tissue having the structure of a normal or pathological thyroid gland, and situated at some definite distance from the normal thyroid, with which it has no connection. He suggested that accessory, allied, and other synonyms for these entities are not desirable terms, but that the most appropriate is "aberrant thyroids," indicating segments which are separated from the parent thyroid.

Fifty-one cases of lateral aberrant thyroid glands have been reported to date. J V Leech, L W Smith, and H M Clute<sup>2</sup> maintain that the paucity of reported cases is due to a failure of many operations to reach the literature, or to a failure to recognize the true nature of these cervical tumors. The diagnosis is usually made by the pathologist. These lateral aberrant thyroids are usually the seat of pathological lesions such as neoplastic formations or inflammatory changes. Billings and Paul<sup>3</sup> report that 70 per cent of lateral aberrant thyroid tumors are of the papillary type. The case here reported is one of an intracystic papilloma of a lateral aberrant thyroid gland.

CASE I—H S, male, aged forty-one years, first consulted us September 30, 1931, complaining of a lump on the left side of the neck of eleven weeks' duration. There was no history of pain, loss of weight, or of a tendency toward progressive enlargement of the tumor. Dysphagia and other pressure symptoms were never noted. The past and present history was irrelevant. Examination revealed a mass about the size of an apricot situated on the left side of the neck over the upper portion of the sternocleidomastoid muscle, and extending up to the lobule of the ear. This mass was firm but elastic, and although freely movable from side to side was apparently non-mobile from above downwards. The skin was not attached to the tumor at any point. Tenderness could not be elicited, nor could a communication with the mouth be established. The superficial lymph-nodes and thyroid were uninvolved. Blood smears and white blood-cell count were normal. Blood-pressure was 220 systolic and 110 diastolic. The urine contained a heavy trace of albumin with a few hyaline casts. There was a moderate degree of left ventricular preponderance.

*Operation*—(J A L) Under avertin anæsthesia, a three-inch oblique incision was made directly over the body of the sternocleidomastoid muscle. Situated in the upper anterior triangle of the neck and firmly attached to the carotid sheath beneath, and to the external jugular and facial veins above and anteriorly, there was a tumor about the size of an apricot which appeared to have a duct at its upper end terminating in the region of the pharynx. The tumor was cystic with a markedly thickened wall and the contents consisted of a yellowish mucoid fluid containing a number of small golden-brown granules. There were many dense adhesions binding the tumor to the structures comprising its bed.

To free the tumor it was necessary to split the fibres of the sternocleidomastoid muscle. With great difficulty the lower pole of the growth was mobilized and the process

of separation was carried out from below upwards. In doing this, some of the cyst contents escaped into the wound. The entire tumor was extirpated and its pedicle, situated at the upper pole, was divided between ligatures. The wound was then flooded with 50 per cent alcohol and closed in layers over a rubber dam. The patient made an uneventful recovery and was discharged from the hospital eight days after operation. He was last seen November 11, 1931, and appeared perfectly well, there being no evidence of recurrence.

*Pathological report*—The specimen consisted of a cystic mass measuring 3 centimetres in diameter. When opened, its lining presented a number of small papillary projections, and its contents consisted of a thick hæmorrhagic grumous material. On section, hæmorrhagic fibrous tissue was seen with many cystic areas showing papillary projections. The cells showed no cavernous changes (Figs 1, 2 and 3).

*Diagnosis*—Papillary cystadenoma of an aberrant thyroid gland.

In order to obtain a clear understanding regarding the mode of origin of an aberrant thyroid, it is necessary to refer back to the embryology of the normal thyroid gland.

The thyroid gland is formed from an evagination of the anterior pharyngeal wall at the level of the second branchial arch. It was originally thought that the thyroid gland had a double anlage, one arising laterally, the other in the mid-line, but the works of Muller, His, Verdun and Tourneaux<sup>4</sup> seem to prove that the thyroid originates from a single median evagination. The thyroid appears in embryos of 4 millimetres as a ventral outgrowth of epithelium in the floor of the pharynx immediately behind the tuberculum impar. This evagination grows into the mesodermal tissue in the ventral wall of the neck, forming a transverse mass of epithelium. This mass breaks into irregular cords of cells which by a further process of budding grow caudally along the anterior surface of the larynx. This mass of tissue is solid and may assume the appearance of a tube but never really becomes one, although it is designated as the thyroglossal duct. This solid mass grows caudally and divides into a right and left lobe which are united by a strand of tissue identical in structure to the lobes which cross over the trachea. The thyroglossal duct may retain its connection with the isthmus for variable periods, reaching usually to the foramen cæcum at the root of the tongue. This duct is customarily divided into a lingual portion which extends from the foramen cæcum to the hyoid bone, a hyoid portion lying in the body of the hyoid bone, and a thyroid portion extending from the hyoid bone to the isthmus of the thyroid gland.

Concomitant with the full development of the thyroid, the thyroglossal atrophies into a fibrous cord which is often designated as the tractus thyroglossus. Occasionally the duct fails to become fully obliterated, resulting in the formation of thyroglossal cysts. Cases of failure of closure of the thyroglossal duct are frequently associated with the presence of rests of thyroid tissue situated along the course of the duct. Occasionally, the duct may terminate in the anterior mediastinal space, in which event aberrant nodes may be found in that location.

The exact origin of lateral aberrant thyroids is still a mooted question.



Fig 1—Portion of tumor showing proliferation of the germinal centres (Low power)



Fig 2—Many cystic areas with papillary projections of embryonic origin (High power)

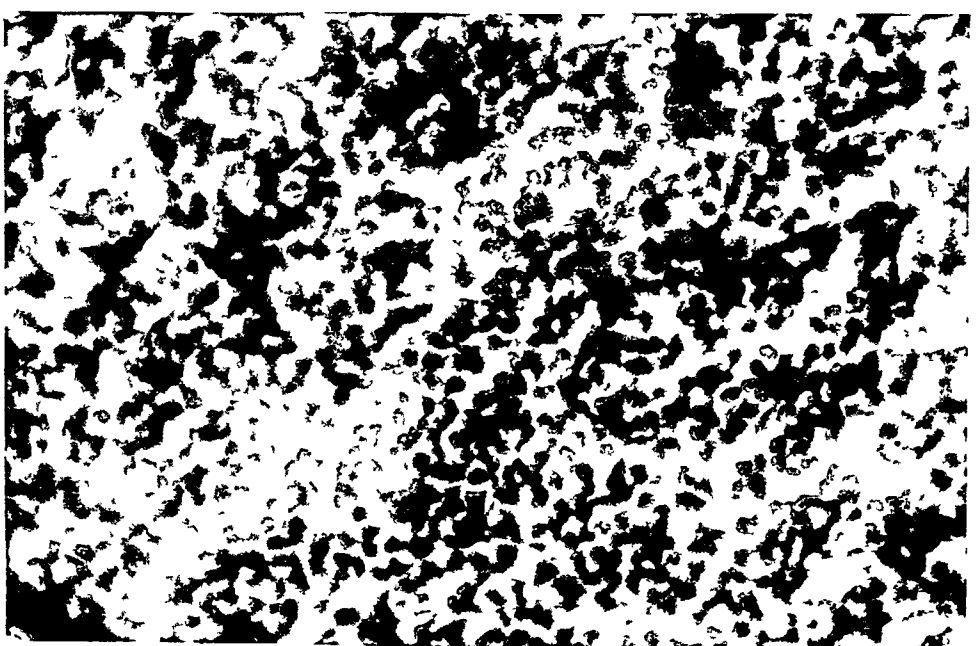


Fig 3—Portion of tumor showing proliferation of the germinal centres (High power)

# LAZARUS AND ROSENTHAL

Some observers are of the opinion that fragments of the thyroid may become detached during the gland's descent from the neck. The best explanation is that given by Grosser,<sup>5</sup> who maintains that these structures develop from clusters of cells arising from the posterior aspect of the fifth branchial pouch (See Fig 4). These cell clusters, in their migration, may fail to meet and fuse with the thyroid proper, and later, as shown by Virchow, they become activated and give rise to tumors.

Seventy per cent of these aberrant thyroids give rise to neoplasms of the

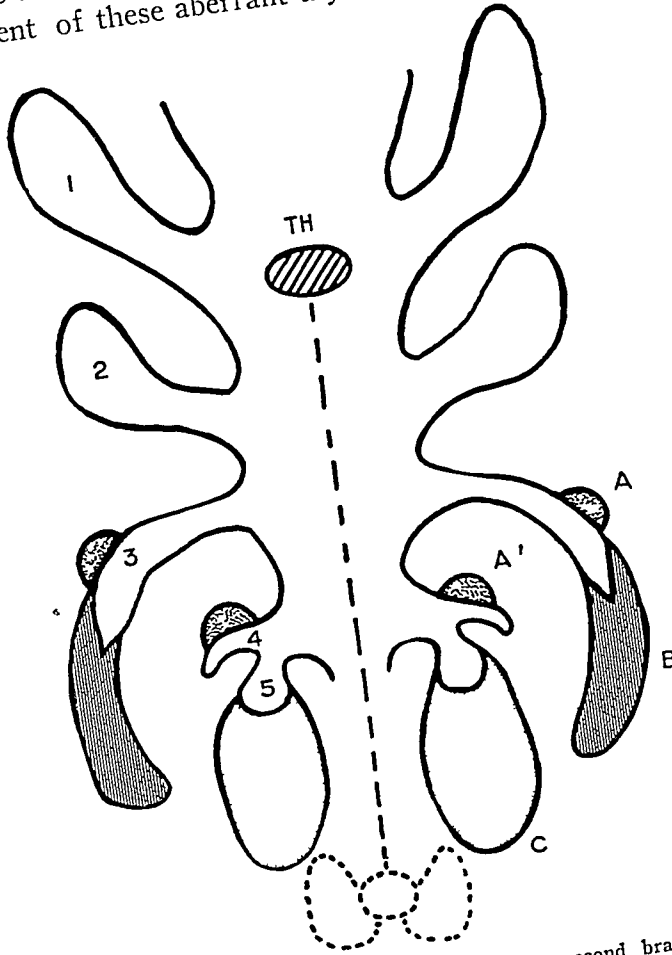


FIG 4—1—First branchial groove, 2—second branchial groove, 3—third branchial groove, 4—fourth branchial groove, 5—fifth branchial groove, A—thymic portion of the parathyroid, A'—thyroid portion of the parathyroid, B—thymus, C—post-branchial body, TH—thyroid (From Crotti's Thyroid and Thymus Lea and Febiger)

papillary type. The other lesions are papillary adeno-carcinoma, epithelioma, alveolar carcinoma and carcinoma. The tumor is usually slow-growing and subject to involutional changes such as cystic degeneration, hæmorrhage and calcification. A well-defined capsule is usually present. They may undergo malignant changes and give rise to metastases. Although the vast majority of these tumors are found in the neck, they may occur in the bones, pleura, pericardium and ovaries. J B Murphy<sup>6</sup> believed that aberrant thyroid nodules were metastatic in character. This view, however, has not been uni-

versally accepted because of the failure to find malignant changes in the thyroid proper. Aberrant thyroids may be found anywhere in the lateral regions of the neck. The most common location is in the mid-portion of the neck beneath the sternocleidomastoid muscle. In a number of cases they are situated in close proximity to the angle of the jaw, and in others may be found lying in the supraclavicular fossa. In Billings and Paul's series of collected cases the tumors occurred in 75 to 80 per cent of the cases in females. The average age was thirty-four for females and forty-two for males. The youngest case was in a girl of twelve years, and the oldest in a woman of sixty years.

Affection occurring within the thyroid frequently produces similar changes within the aberrant rests, and conversely when adenoma is suspected within an aberrant thyroid, the thyroid proper should be carefully inspected for a similar disease.

*Differential diagnoses*—One must differentiate lateral aberrant thyroids from (1) Carotid body-tumors, (2) tuberculous glands, (3) branchial cysts; (4) Hodgkin's disease, (5) secondary or metastatic carcinoma, (6) lymphosarcoma, (7) lymphatic leukemia, (8) syphilitic glands.

Tumors of the carotid glands are of infrequent occurrence. The carotid bodies are situated at the bifurcation of the common carotid artery. Microscopically, they are classified as endothelioma or perithelioma, and show low-grade malignant properties early in their development, but later tend to become actively malignant. Their growth shows a slow and progressive course. Tuberculous nodes occur usually in younger patients and are as a rule bilateral. They are multiple and have a tendency to become adherent to one another and to the skin overlying them. Diagnosis can be established by surgical measures, such as removing a node for biopsy. When spontaneous necrosis occurs, leading to a discharging fistula, the diagnosis of tuberculous nodes is self-evident. Confirmatory evidence of an old tuberculous lesion in joints, spine and peritoneum may be elicited. Absence of pulmonary signs is not at all unusual in these cases. Lateral embryonic remnant cysts are due to imperfect closure of branchial clefts and are sometimes known as branchial cleft cysts. The contents of these cysts may be serous, mucous, gelatinous or may resemble the contents of a sebaceous cyst, sometimes containing cell detritus, epithelium and frequently cholesterol crystals. The lining membrane of these lateral cysts as well as aberrant thyroid cysts is epithelial.

CASE II—(*Branchial Cyst*) A W, female, aged twenty-nine years, first consulted us February 22, 1932, complaining of a lump on the right side of the neck. A pre-operative diagnosis of a possible lateral aberrant thyroid was made but the diagnosis of branchial cyst was later established by microscopy. The tumor, of three months duration, had grown progressively larger until it had reached the size of a small hen's egg. There were no pain, no dysphagia, no gastro-intestinal symptoms and no loss of weight. One week prior to the consultation the patient was receiving Rontgen therapy which caused a marked increase in size of the mass. The family history was negative. As to her past personal history, there was nothing of importance except an occasional attack of

cervical adenitis years before. She was well nourished, not appearing acutely ill. Eyes, ears and nose showed no disease. The mouth revealed large and cryptic tonsils. The larynx appeared normal. The heart and lungs were negative. The blood-pressure was 130 systolic and 80 diastolic. A roentgenological examination of the chest showed a few increased hilar shadows and some calcified nodes.

There was a mass about the size of a large English walnut on the right side of the neck in front of the upper portion of the sternocleidomastoid muscle. The mass was hard and gave a sense of slight fluctuation and could be moved upon the deeper structures. It was not attached to the overlying skin, and there was no tenderness elicited. The trachea was pushed to the left of the mass. The other glands and the thyroid were not involved.

The hæmoglobin was 70 per cent (Sahli), red blood-cells, 4,700,000, white blood-cells, 12,000, and the differential blood smear was normal.

*Operation*—(J. A. L.) The tumor was removed February 23, 1932. A three-inch vertical incision along the anterior margin of the sternocleidomastoid muscle was made. Situated beneath the sternocleidomastoid muscle and lying upon the large vessels of the neck in the anterior triangle and extending up toward the mastoid process there was a tumor about the size of a small hen's egg. The tumor was intimately adherent to the muscle and the carotid sheath. The tumor was mobilized from its bed and removed with great difficulty. In its removal, the tumor was opened and a considerable purulent discharge spilled into the wound. The wound was then bathed with weak iodine and alcohol, and a small tube was introduced for drainage. The muscles were closed with interrupted plain catgut sutures, the fascia with interrupted chromic, and the skin with interrupted silk. The anæsthesia administered was avertin, which was supplemented by gas and oxygen. The patient made an uneventful recovery and was discharged from the hospital one week after the operation.

*Pathological report*—The specimen consists of a cystic tumor mass that measures 4 by 2½ centimetres. On section the mass is filled with whitish mucoid material and the wall is thick and gelatinous in character, with a few small papillomatous projections toward the lumen.

Histological section of the cystic tumor shows the cyst-wall to consist of squamous epithelium, possibly embryonic in origin, with much lymphoid tissue congestion and some necrotic areas. Many pus cells are seen. There are no giant cells or other signs of tuberculosis. *Diagnosis*—Branchiogenic cyst (infected).

So closely did this case simulate the first one that it was with exceedingly great difficulty that the differential diagnosis was made even on histological section.

Hodgkin's nodes are usually multiple, discrete and fail to undergo softening as in the case of tuberculous nodes. There is also a failure of the nodes to coalesce or to become adherent to the skin or deeper parts, or to form a fistulous tract. Splenic enlargement is frequently associated with Hodgkin's disease. Diagnosis is made by histological study of the extirpated node.

Secondary or metastatic nodes in the neck frequently simulate aberrant thyroids, and when found one must always think of a primary lesion in the neighborhood. This lesion is usually a squamous carcinoma of the buccal cavity, lip, tongue, palate or the pharynx, larynx or œsophagus. Carcinoma is a disease of the middle and later periods of life. The rapid enlargement of nodes, their stony hardness, the manner in which they become fixed to the deeper structures and skin leave little doubt as to the diagnosis.

## ABERRANT THYROID GLANDS

Lymphosarcoma in the cervical nodes is of no infrequent occurrence. In lymphosarcoma, the systemic character of leukemia is missing, and the spleen, liver and marrow are rarely involved. The disease is usually found among robust males between twenty-five and fifty-five years of age. Histologically, the tumor is composed of lymphoid cells of variable size lying in an atypical reticular tissue. Lymphosarcoma can be distinguished from other forms of lymphoma by its local destructive tendency and by the formation of true metastases in distant organs. Leucocytosis is usually present and may be so marked as to suggest leukemia. The excess cells are usually of polymorphonuclear type. X-ray therapy after extirpation of the tumor has often temporarily arrested the progress of the growth.

In lymphatic leukemia there is an increase of lymphoblastic cells accompanied by generalized node enlargement. None of the other conditions exhibits pathognomonic blood changes seen in lymphatic leukemia.

Syphilitic nodes rarely reach great size. They are almond-shaped and firm, painless and do not become adherent to the skin or deeper parts. A history of chance with a positive Wassermann reaction differentiates syphilis from the other conditions.

The prognosis is good in cases of complete extirpation. Failure to remove the growth may result in malignant changes occurring in it as was seen in the case reported by Wohl,<sup>7</sup> in 1917. In performing the operation, one should aim at the complete extirpation of the aberrant tissue, since failure of removal often results in recurrence. Operative procedures are difficult because of the close proximity of the tumor to important vascular and nerve trunks. The capsule should be included in the extirpation. Following operation, X-ray treatment should be given in all cases.

*Summary and Conclusions*—(1) Lateral aberrant thyroids are of rare occurrence. (2) These tumors arise from the fifth branchial pouch. (3) Malignant changes frequently occur within these aberrant thyroids. (4) The majority of lateral aberrant thyroids occur in females. (5) Clinically, the differentiation between branchial cyst rests and lateral aberrant thyroids is impossible. (6) Complete extirpation followed by Rontgen therapy is the procedure of choice in the management of such tumors.

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# PROLAPSE OF THE RECTUM

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CONSIDERABLE divergence of opinion exists regarding pathological changes, classification, and treatment of rectal prolapse, in other words, an external prolapse which one observer considers caused by intussusception of the rectosigmoid, another may describe as true prolapse of the rectum. Prolapse which one observer may classify as grade 3, another may classify as grade 1. Similarly, one surgeon may recommend local or non-surgical treatment, and another may suggest some type of intra-abdominal operation. In an attempt to correlate and classify the basic pathological physiology and various methods of treatment of this condition we have reviewed the cases of prolapse of the rectum observed at The Mayo Clinic in recent years. The cases have been classified as (1) Prolapse of the rectal mucous membrane, (2) prolapse of the rectum proper (procidentia), which may be graded 1 to 4, depending on the extent of the protrusion, and (3) intussusception of the rectosigmoid.

*Prolapse of the Rectal Mucous Membrane*—When prolapse of the rectal mucous membrane occurs, the small ring of mucosa which normally protrudes from the anus during the act of defecation fails to retract on completion of this act. Straining or frequent stools accentuate the protrusion. The mucosa becomes redundant and the submucosa is stretched and relaxed. The position of the other layers of the rectal wall remains unaltered. This condition does not constitute true prolapse of the rectum. Anatomically, it bears a marked similarity to the protrusion of redundant gastric mucosa through the pyloric sphincter into the duodenum. It is most common in childhood or old age.

*Occurrence During Childhood*—Prolapse of the mucous membrane is more common during the early years of life than at any other time. Lockhart Mummery<sup>3</sup> reported fifty cases in which the average age was two and a half years, the youngest patient was aged three months and the oldest five years. The prolapse is most prone to develop among poorly nourished children, particularly following debilitating diseases during which a large amount of the ischiorectal fat disappears. Constipation and diarrhoea predispose to the development of prolapse, in the former excessive straining and, in the latter, repeated stools are the contributing factors. Intestinal parasites, whooping cough, rectal polyps and measles are the more commonly associated

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systemic conditions    Diarrhœa of any origin is the commonest single etiological factor

Anatomically, numerous hypotheses have been advanced to explain the development of the condition among children (1) The weak fixation of the rectal tissues in childhood, the fibrous tissues being more elastic and less firmly anchored than in adults, (2) absence of the sacral curve, the course of the rectum is straighter, in comparison with that of the adult, and (3) the high position of the bladder and uterus of the infant. The true etiological significance of these factors is a matter of conjecture and difficult to determine for any individual case. Only rarely is any developmental defect observed which is directly responsible for the occurrence of this type of prolapse.

*Occurrence During Adult Life*—Prolapse of the mucous membrane of the rectum occurring among adult patients is usually associated with some preexisting pathological condition of the rectum which is at least indirectly responsible for the development of the prolapse. It is usually secondary to some type of disturbance which causes excessive straining at stool. The primary condition may be the result of local or systemic disease. Locally, hemorrhoids, polyps, stricture, atrophic or injured sphincter, are the most common preexisting conditions. Occasionally, disease of adjacent organs may constitute a predisposing factor. Less often, some type of urinary obstruction may be responsible. Usually the development of prolapse is gradual. The rectal mucosa fails to retract following defecation and the protrusion grows slowly, enlarging somewhat with each act of straining, whether it is sneezing, coughing, voiding or defecating.

*Diagnosis*—The condition is usually obvious on inspection of the involved area. A rosette of mucosa is present around the anal margin. The color of the protruded tissue depends on its blood supply, ranging from pink to red, or from purple to black in case of strangulation. The latter complication is very uncommon in this type of prolapse. If the prolapse is recent the tissue is pink and moist, later it tends to become redder and to bleed easily on slight trauma. Occasionally, in a long-standing case, the tissues appear pale and leathery. Distinction from intussusception presenting at the anus is established by inserting a finger in the rectum immediately lateral to the protrusion. This is impossible in mucosal prolapse. Hemorrhoids may be excluded by the absence of a central depression. Polyps most always have a pedicle. In a true prolapse of the rectum proper the entire wall of the rectum descends and the condition may be readily recognized.

*Treatment*—The treatment may be medical or surgical. Frequently, in the early case, non-operative measures suffice to effect cure, provided any known etiological factors are eliminated. The essential factors of medical treatment are (1) Eradication of local causes, dilatation of strictures, treatment of hemorrhoids or polyps, and so forth, (2) establishment of normal bowel habits, with elimination of straining at stool, and (3) general hygienic care and treatment of any coexisting debilitating disease.

Aside from removal of local causes, the readjustment and regulation of the bowels are of utmost importance. This frequently can be accomplished by attention to the diet and the use of appropriate lubricating oils or laxatives. Violent purgatives should not be employed. Locally, the prolapse should be reduced following each defecation, this is accomplished, following suitable cleansing of the parts with warm water and lubrication with olive oil or liquid petrolatum, by gently compressing and pushing the mucosa upward within the anus. Reduction is maintained between stools by strapping the buttocks firmly together with adhesive tape. Occasionally, when the prolapse has existed for a considerable time, and if there has been some degree of constriction to the blood supply, reduction may be very painful and local anæsthesia may be necessary, although it should be avoided if possible. Excessive downward pressure during evacuation can be partially eliminated by the horizontal position on the back or side during defecation. Massage, mechanical devices, electricity or astringent solutions or ointments are all equally ineffective and are not recommended.

Frequently, all medical measures fail and some type of surgical procedure becomes necessary. Fraser has recently reported fifty cases in which treatment by local injections of alcohol was successful. This method is easy of application and has much to recommend it when productive of so efficient results. One injection is usually sufficient, rarely must a second injection be given. In the technic described by Fraser, the index finger is placed in the rectum to serve as a guide for the insertion of a fine needle which is passed through the mucocutaneous juncture into the region of the submucosa. Approximately 0.2 cubic centimetres of absolute alcohol is injected at four equidistant points around the anus, making a total injection of one cubic centimetre. Following this procedure the buttocks are strapped for twenty-four hours, at the end of which time the bowels are opened. If the injection method is not employed, cauterization may be carried out either with fuming nitric acid or, preferably, with the actual cautery. Excision is one of the surest methods for effective cure, provided the etiological factors are eliminated. This is readily accomplished and is not more disabling than other surgical procedures.

*True Prolapse of the Rectum (Procidentia)*—True prolapse of the rectum is characterized by the presence of all layers of the rectal wall in the protrusion. Two distinct types or grades may be recognized. One type starts below the reflection of peritoneum on the rectum and the other originates above this level. The former is characterized by absence of a marginal sulcus (Fig. 1). The prolapse begins at the anal margin and is continuous laterally with the mucocutaneous border. The second type, which begins above the reflection of the pelvic peritoneum, has a definite sulcus laterally, since the lowermost portion (anal margin) of the rectum does not participate in the descent. It is this variety of prolapse which is most representative of true rectal prolapse. In comparison with prolapse of the mucosa only, this type is less common and occurs almost always among adults.

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*Etiology*—The basic anatomical defects responsible for the development of complete prolapse are more complex than for the incomplete form. The same underlying factors are existing in both types, however, varying only in degree. Considerable anatomical investigation has afforded evidence that complete prolapse of the rectum is similar to hernia. Moschcowitz<sup>4</sup> emphasized the importance of the transversalis fascia and mentioned the ubiquitous presence of this layer of fascia which is always found external to the peritoneum. It lies beneath the large vessels and viscera in the abdomen, and is penetrated only where blood-vessels or viscera normally make their

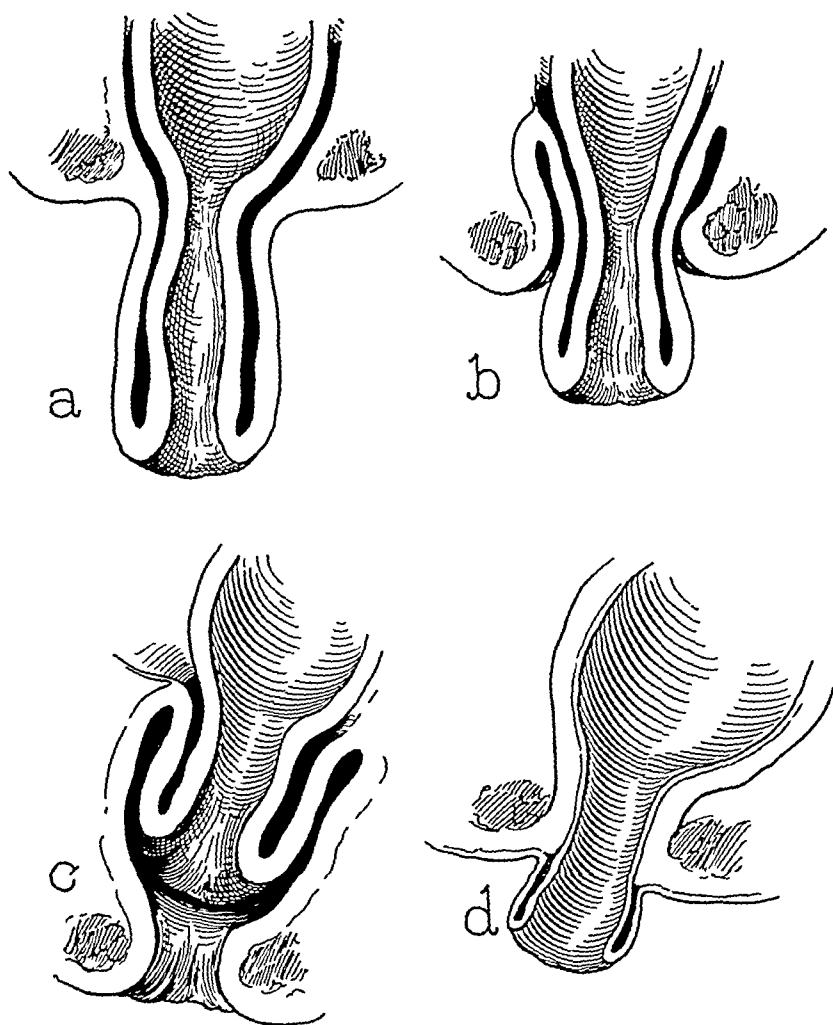


FIG 1—Illustration of different grades and types of procidentia

exit from the peritoneal cavity. As a rule, it is sufficiently strong to prevent herniation. Pathological influences, such as increased intra-abdominal pressure or a pushing force from within, are usually essential to the production of a weakness sufficient to cause herniation. In the case of the rectum, straining as in obstinate constipation, incessant diarrhoea, increased intra-abdominal pressure, trauma incident to parturition, and so forth, are the usual factors responsible for prolapse.

Prolapse of the rectum is similar to a sliding type of hernia. The close adherence anteriorly of the peritoneum to the rectum is the reason, as stated by Moschcowitz, why no true sac exists (Figs 2 and 3). The levator ani muscles and their associated fascia combine with the other parts of the

perineal body to retard the downward protrusion. The musculature of the rectal wall also tends to prevent downward progress of the bowel. However, this is relatively weak and soon yields to the constantly increased intra-abdominal pressure. As the prolapse increases, the posterior wall of the rectum and, later, the sacrum and coccyx prevent its backward extension. The course of the descent is thereby changed and extends at first downward and forward, and finally backward toward the anus until the protrusion appears externally.

*Symptoms*—The diagnosis of rectal prolapse usually affords little difficulty. The cardinal features are a protruding mass from the anus (Fig 4), associated with obstipation and, subsequently, in the advanced cases, with incontinence. The protrusion may vary in size from a few inches to one of considerable length. In the early cases, manual reduction is possible, but in the later cases it is followed by immediate recurrence. At first the pro-

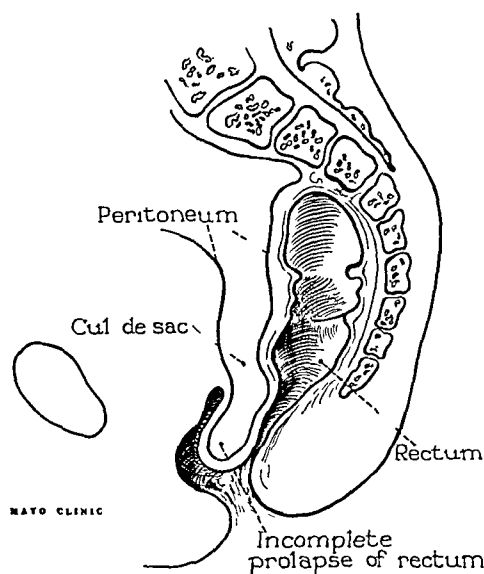


FIG 2

FIG 2—The basic anatomical changes occurring in prolapse of the rectum (incomplete prolapse) (After Moschowitz)

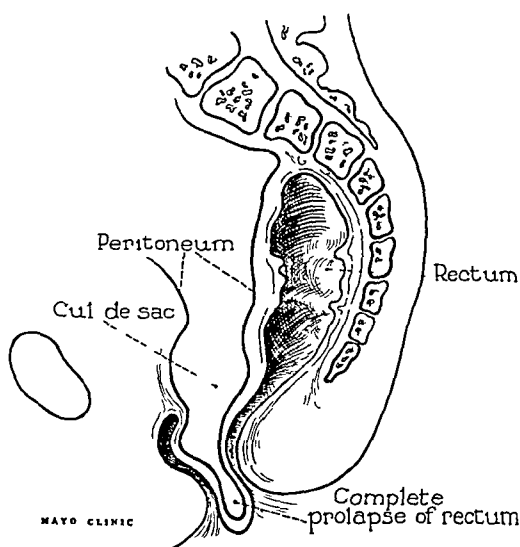


FIG 3

FIG 3—Complete prolapse of the rectum (After Moschowitz)

truding bowel retains its normal color and the mucosa has a healthy appearance. Later, due to constant irritation and trauma, the mucosa becomes inflamed and œdematous and frequently constitutes a reddened, oozing mass which may have one or more areas of ulceration. There is usually a constant secretion of mucus which adds to the disagreeable nature of the lesion. As a rule pain is not a prominent feature. In advanced cases, especially if patients are elderly, incapacity and debility are frequently pronounced and often sufficiently severe to confine the patient to bed. Sometimes incarceration or strangulation of the bowel may occur, as in the case of any other hernia.

*Treatment*—General hygienic measures are essential in the care of these patients as an adjunct to any form of treatment directed toward effecting cure. The treatment may be medical or surgical. As a rule, medical meas-

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Fig 4—Typical clinical picture of prolapse of rectum

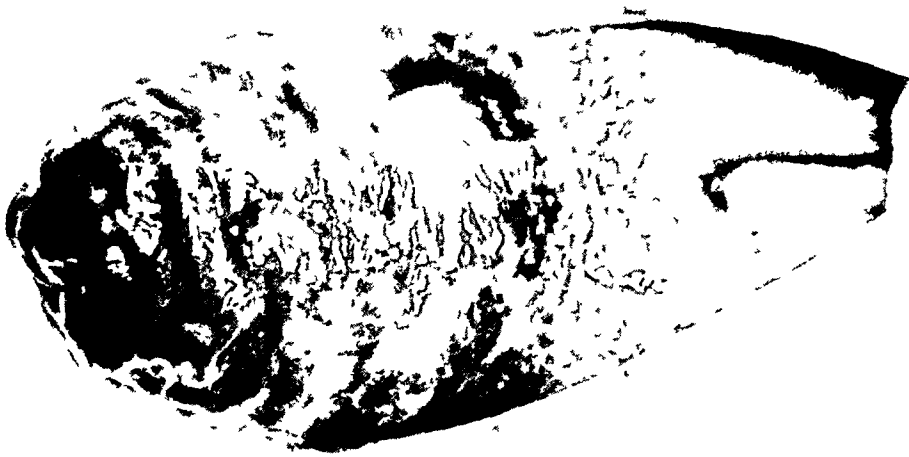
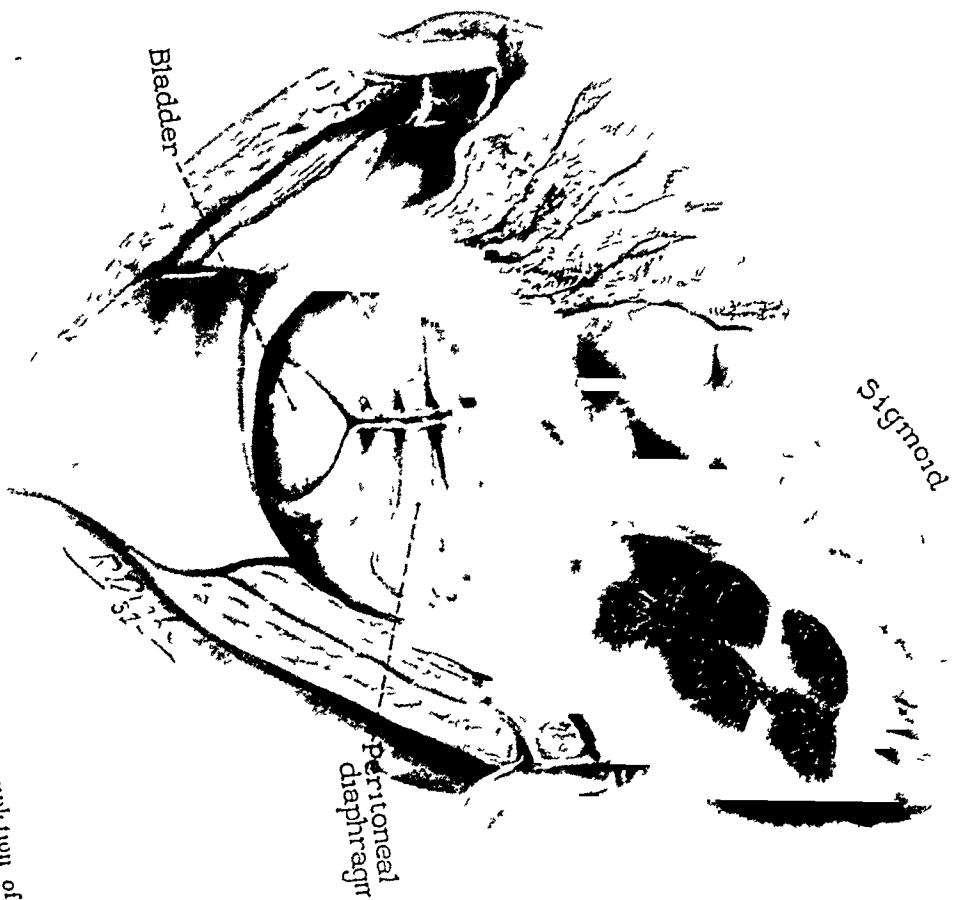


Fig 5—Appearance of the reconstructed pelvis following completion of the Moschowitz operation



ues are effective only in the early cases when the protrusion is small and not associated with advanced, secondary anatomical changes

Non-operative procedures may be classified as (1) Soothing ointments or lotions to relieve the irritated mucosa, (2) submucous injections of astringents, such as absolute alcohol, ergot, and so forth, (3) mechanical supports, and (4) electric treatments. It is evident that treatment of this type is more palliative than curative.

Numerous types of operative procedures have been suggested for the cure of rectal prolapse.

(1) Operations for narrowing the anal aperture and adjacent rectum, such as resection of a wedge-shaped segment from the posterior wall of the rectum, cauterization or removal of the rectal mucosa, twisting the rectum, subcutaneous injections of paraffin at the level of the sphincter, and ligation by a loop of silver wire at the level of the anal orifice.

(2) Procedures attempting to strengthen the rectal supports from below, such as plastic operations which utilize the adjacent gluteus muscles, procedures attempting to use the levator ani muscles by suturing them closer together, plastic operations as suggested by Hofmann<sup>1 2</sup> who made an H-shaped incision posterior to the anus and stretched the side-to-side denudation in an anteroposterior direction and closed the incision with strong, supporting sutures.

(3) Various types of fixation operations, such as rectopexy of the Verneuil<sup>3</sup> type, which consists of removal of the coccyx and suture of the rectum to the integument, and sigmoidopexy, in which the sigmoid is sutured to the anterior abdominal wall, there have been numerous modifications of these various procedures. In general, rectopexy is usually unsatisfactory, as it fixes mainly the posterior wall of the rectum which plays but a small part in the production of prolapse. Sigmoidopexy, with fixation to the anterior abdominal wall, has been received with much favor in the past. This operation is easily performed and in mild cases gives satisfactory results. We have abandoned this procedure, however, because it appears dangerous in certain cases and, furthermore, because recurrence will invariably develop if the prolapse is severe.

(4) Operations directed toward cure by resection of the prolapse may be done with a ligature, an elastic bandage, or by amputation with a knife. The outer and inner cylinders are then joined by suture at the line of section. The results of this type of operation have not been as satisfactory as might be expected. As a rule, these procedures have little in their favor. Resection may become necessary, however, if the prolapse becomes incarcerated or gangrenous.

(5) An operation suggested by Moschcowitz, in which the cul-de-sac of Douglas is obliterated, is based on the theory that true rectal prolapse is a hernia of the sliding type. We believe this supposition to be fundamentally sound and anatomically accurate. The Moschcowitz operation has afforded very satisfactory results in our hands. In the last five years it has been em-

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ployed in nine cases of major prolapse of the rectum. The results have been highly satisfactory in seven of these cases. Many of the patients had undergone numerous types of treatment elsewhere before this operation was performed at the clinic.

The principles underlying the technic of the Moschcowitz operation are relatively simple and easy of application. The operation is uniformly applicable in both sexes. It is somewhat more difficult to perform it on men because of the smaller and deeper pelvis. The true pelvis is largely obliterated and a new pelvic floor is formed. By placing row on row of silk or linen purse-string sutures around the cul-de-sac, the operation is started at the bottom of the pelvis and carried upward in subsequent layers several centimetres apart until the entire pelvis is obliterated. Fig 5 illustrates the appearance of the pelvis at the conclusion of the operation. Care should be employed in placing the sutures to avoid the ureters and internal iliac vessels. One should incorporate a certain amount of subperitoneal tissue in the suture line to strengthen the line of closure. A convenient procedure may be followed by placing all of the sutures before any of them are tied and then proceeding from below upward, tying them in order. It is very important to insert a large-sized rectal tube into the lower part of the bowel as far up as the sigmoid to obviate the possibility of constricting the rectum during the operation. This tube is anchored with a silkworm stitch placed through the anus. It is allowed to remain in place for six to eight days after operation. If women have passed the menopause, ventral fixation of the uterus may add to the success of the operation, if they are younger it is important to remember that parturition almost inevitably leads to a recurrence. Fixation of the sigmoid to the anterior abdominal wall, which has been recommended, is not considered advisable.

After operation, it is desirable to place the patient on a low-residue diet and administer mineral oil daily for a period of at least eight days, when the rectal tube is removed. The diet may gradually be increased and daily enemas of oil given. The patient should remain in bed for two or three weeks following the operation.

*Intussusception of the Rectosigmoid*—Intussusception of the rectosigmoid, frequently referred to as a third-degree prolapse, is, strictly speaking, not a true prolapse, but an intussusception of the lower segment of sigmoid and rectosigmoid into the ampullary portion of the rectum. From a clinical point of view, however, these cases have many features in common with those of true major prolapse of the rectum. Etiologically and symptomatically they are similar. Surgically, they are best treated by obliteration of the true pelvis, after the technic described by Moschcowitz. The diagnosis is readily determined by digital or proctoscopical examination. Unlike intussusception in other portions of the large bowel, strangulation, complete obstruction or adhesions of the invaginated surfaces rarely occur. Depending on the extent of the lesion, the bowel may or may not protrude



through the anus. A case the history of which follows, is illustrative of this type of lesion.

A physician, aged forty-three years, first examined at The Mayo Clinic October 19, 1931, complained of a "dragging down" sensation in the lower part of the abdomen and a relaxed anal aperture. Constipation was severe enough to require a daily enema. The patient complained of severe exhaustion which he attributed entirely to the rectal disorder. In other respects his general health was good and he had not lost weight.

The patient weighed 147 pounds. The results of general examination and of laboratory tests were all negative. Proctoscopical examination disclosed a mobile and redundant rectosigmoid which prolapsed down into the rectum. A diagnosis of prolapse of the rectosigmoid was made.

October 23 a Moschcowitz type of operation was performed. The tissues of the pelvis were found to be extremely relaxed and redundant and the true pelvis was obliterated. The immediate post-operative convalescence was uneventful and the patient left the hospital two weeks after operation. When last heard from, six months afterward, he was well and completely relieved of all previous rectal complaints.

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# PRURITUS ANI ITS ETIOLOGY AND TREATMENT \*

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A SURVEY of the literature on pruritus ani leads to the conviction that the etiology of this very prevalent complaint is not understood and that its treatment is quite unsatisfactory. A recent study of this condition at the Stanford Clinic has made possible certain definite conclusions as to its etiology and has led to more satisfactory results in its treatment.

Pruritus ani is the *symptom* of localized itching about the anus. It is not a clinical entity, always having the same fundamental cause, and the search for causative factors has led certain investigators far astray. A brief summary of the many and varied theories of etiology seems desirable before presenting the writer's understanding of the condition.

Perhaps the earliest conception of etiology was that of an hysterical or neurogenical background as the fundamental trouble. Even as recently as 1926, Rice<sup>1</sup> believed that there was little doubt that pruritus ani "is largely influenced by an inherited or acquired neurotic condition." In 1929, Smith<sup>2</sup> felt that in many cases it "is an outlet for emotional stress." Beach<sup>3</sup> propounded the interesting hypothesis that "periods of financial depression are not an unlikely factor."

Innumerable constitutional disturbances have been held responsible, as, for example, gout, diabetes, rheumatism, lithæmia, uræmia, hepatitis, nephritis, syphilis, tuberculosis, malaria, glycosuria, typhoid disturbance, and ovarian dysfunction. Generalized itching does occur with at least some of these constitutional diseases. But this must not be confused with the condition under discussion, which is that of localized itching in the anal region. Lockhart-Mummery,<sup>4</sup> in a discussion of diabetes as the possible cause of pruritus ani, states that he has never seen such a case. The unanimous opinion of many colleagues consulted denies the association of localized perianal itching with any of these conditions.

Another somewhat fanciful theory is that propounded by Clemons,<sup>5</sup> who believes that pyorrhœa alveolaris is the underlying source of the trouble. Kiger<sup>6</sup> resorts to that tottering concept of a distal focus of infection, naming specifically tonsillitis, alveolar abscess, sinusitis, chronic appendicitis, and cholecystitis.

There has been an increasing trend in support of the theory that pruritus ani is a referred sensation caused by disease in some distant organ. At first contiguous organs, such as the prostate, the seminal vesicles, the bladder, and

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\* Read before the Surgical Section, San Francisco County Medical Society, August 16, 1932.

the urethra were implicated. The indictment was later broadened to include all the abdominal viscera.

Pain as a referred symptom of disease occurs frequently and by a well-understood mechanism. But itching is never encountered elsewhere in the body as a referred sensation. The pain of biliary colic often radiates through to the back and to the right shoulder blade. But it never occurs at the anus! If itching were to occur as a reflex symptom of gall-stones, it should occur over the right shoulder blade, not at the anus. The pain of renal colic may radiate along the course of the ilio-inguinal nerve through the groin to the scrotum and to the inner side of the upper thigh. It never occurs at the anus. If itching were to occur as a reflex symptom of renal colic it should occur in this same region and not at the anal canal.

It is difficult to accept the theory of reflex origin as reasonable, nor has clinical experience necessitated recourse to this ill-conceived hypothesis.

Attention has been so focused upon the remote causes of pruritus ani that local causes have been neglected and even when obviously present have been treated with contempt. Proper investigation of possible local causes requires special instruments, technic, and experience. cursory external inspection and the blind insertion of a gloved finger into the rectum is more often than not totally inadequate. Direct visual inspection of the entire length of the anal canal, the mucocutaneous line, and at least the lower two inches of the rectum, by means of a properly devised and adequately lighted anoscope, is imperative. Only then can one obtain a thorough understanding of the local mechanical and infectious factors involved. *Experience has shown that there is always a local cause for the symptom of localized anal itching.*

Crookall,<sup>7</sup> in 1912, pointed out an important fact in relation to this condition. The entire length of the anal canal up to the mucocutaneous line at the upper end is lined with stratified squamous epithelium which is notably lacking in the usual horny layer to which the skin elsewhere in the body owes its impermeability and in the fibrous tissue of the reticular layer to which the skin elsewhere owes its toughness. Because of this fact, maceration, erosion, and splitting of the anal skin are easily produced by factors which elsewhere in the body would have no effect, with a consequent irritation of the underlying nerve-bulbs.

The essential factor in the production of itching is the abnormal presence in the anal canal of an irritative secretion or discharge. A number of conditions may be responsible for this. The first group to consider includes those conditions which allow an abnormal seepage of the ordinary secretions of the rectal mucosa into the anal canal. Normally, this canal is held firmly collapsed throughout its entire length by the encircling sphincter muscles, with the firmest occlusion at the level of the upper end of the canal. This prevents any leakage of rectal contents into the anal canal except at moments of defecation. Any mechanical interference with the normal closure of the canal may allow constant leakage with a resultant maceration and irritation of the wall, inciting itching. This may be caused by a relaxed sphincter muscle

either neurogenical or post-operative. Internal hæmorrhoids may prolapse far enough into the anal canal to prevent proper closure, allowing leakage, even though the prolapse is not far enough to be appreciated by the patient. Hæmorrhoidal masses beneath the skin of the upper end of the canal may have the same effect. These are really external hæmorrhoids, being covered by stratified squamous epithelium, although there may be no evidence of their presence on external examination. A hypertrophied papilla may be responsible.

In addition to these mechanical factors, infectious discharges may also produce irritation of the anal canal. Pockets with inadequate external drainage may develop above hæmorrhoids or in enlarged crypts. Erosion of the delicate mucous membrane by some minute foreign body may occur, with the development of a low-grade infection. In the case of hæmorrhoids, inadequate closure of the anal canal may allow the irritative discharge continually to invade the canal. In cryptitis, infection often burrows beneath the anal skin, which becomes friable and may split with the formation of a small fissure or sinus tract. Here, again, an irritative discharge has continual access to the anal canal.

A specific infection of the skin of the anal canal by *streptococcus fecalis* was advanced by Murray<sup>8</sup> as the etiological cause of pruritus ani. While this was momentarily hailed as a great discovery, subsequent work by Montague<sup>9</sup> and others failed to confirm any specific relationship. Montague was also able to show by a careful study of microscopical sections of anal skin from patients with pruritus ani that while occasional organisms were found in the superficial eroded layers of the skin, there was no appreciable bacterial invasion.

The possibility of a mycotic infection as the causative agent was first mentioned by Ball<sup>10</sup>. Several casual references to this as an occasional cause are found in the more recent literature. The only available studies from this viewpoint are those of Castellani<sup>11</sup> and of Terrell and Shaw<sup>12</sup>. In 1925, Castellani reported careful mycological studies on all cases during a period of thirteen years, 20 per cent of which showed epidermophytosis present in scrapings made from the anal or perianal skin. Terrell and Shaw, in 1928, confirmed Castellani's work, but their results are rather indefinite.

For the past year, Doctor Chope, of the department of bacteriology, has undertaken mycological studies in those patients in which we suspected the possibility of a mycotic infection. The suspected cases showed a characteristic picture. The skin was gray and sodden in appearance, with areas of erosion hidden in the crevices of deep longitudinal folds. The skin was so thickened and rigid that when the buttocks were pulled apart the anal canal appeared funnel-shaped. In contrast to this type of case is that in which there is little evidence of thickening of the skin, the surface is smooth and moist, often with weeping excoriations resulting from scratching.

A fungus infection was suspected in eleven cases. In three of these direct smears made from scrapings taken from areas of erosion showed branching

septate mycelia. In no case was it possible to culture a fungus on Sabouraud's medium. Treatment with a fungicide improved the appearance of the anal and perianal skin, with healing of ulcerations, softening of the skin, and a return to fairly normal appearance. However, complete relief from pruritus did not result in a single instance. In every case pathological conditions such as those described as primary were found. Nine of these patients have been cured completely by treatment of these underlying conditions. The other two have not as yet undergone treatment. This rather small series suggests that secondary infection by fungi may occur in the moist, macerated skin resulting from a chronic, irritative discharge, but that it is not the fundamental cause of the itching.

*Treatment*—Methods of treatment are as myriad as the hypotheses of origin. Being convinced of the universal presence of a local cause, I am equally convinced that the only logical and satisfactory treatment for obtaining permanent relief must be that directed toward the cure of the local cause.

Removal of the prostate, the ovaries, the uterus, the appendix, the gall-bladder, or the teeth is based upon a fallacious premise and is useless. All of these procedures have been advocated and performed.

There are many types of therapy directed at the secondary changes which occur in the anal skin, without endeavoring to remove the primary cause. To be sure, some measure of relief is sometimes obtained by such methods of treatment, but the results are neither satisfactory nor permanent. Radiation is one such form of therapy. Extensive burns following such treatment resulting in years of suffering present convincing evidence that radiation gives little relief and may do great harm. While ultra-violet light may toughen skin and inhibit bacterial growth, this form of therapy does not strike at the true causative factors. Ionization therapy was inaugurated in 1921 by Rolfe,<sup>13</sup> in an endeavor to attack the bacteria supposedly buried deep in the anal skin. His average course of treatment was three times weekly for five months. Published results show some relief in 50 per cent of his cases.

The utilization of specific and non-specific vaccines has been advocated by many authorities following the successes reported by Murray, in 1911. In 1924, Montague<sup>9</sup> concluded that it was "totally unsatisfactory." Its status is the same today. Hazen,<sup>14</sup> in 1923, maintained that what success had been obtained by vaccine treatment probably was the result of protein shock. The latter has not been proven of any value.

Jamison,<sup>15</sup> in 1918, advocated colonic flushes at temperatures of 125-150° F, claiming that hot water is antiphlogistic, antispasmodic, antiseptic, antacid, antifatulent and anodyne, its action softening indurated and cicatricial tissue, equalizing the circulation, and stimulating secretion and excretion. In short, it would appear to do everything but cure the itching.

Numerous methods have been devised for blocking the sensory nerve endings of the anal and perianal skin. Complete relief may be obtained by some of these methods for from three to twelve months, but, unless the

causative pathological condition is rectified, this is not a permanent cure. Probably the first procedure of this type was the undercutting operation devised by Sir Charles Ball.<sup>10</sup> Variations of this operation have been offered from time to time by Mathews,<sup>16</sup> Allen,<sup>17</sup> Hanes,<sup>18</sup> and others. A much simpler and equally effective means of blocking the sensory nerves is by subcutaneous injection of some one of various sclerosing or anæsthetizing solutions. Stone<sup>19</sup> employs 95 per cent alcohol, Goldbacher<sup>20</sup> advised 5 per cent phenolized oil, Yeomans<sup>21</sup> has produced benacol, and Gabriel,<sup>22</sup> A B A solution. Hanes<sup>23</sup> has found 1:3000 hydrochloric acid satisfactory. The solution of choice is probably one-third of 1 per cent quinine and urea hydrochloride as advocated by Yeomans, which can be injected in considerable quantities without the danger of sloughing apt to occur with certain of the other solutions mentioned. The addition of enough novocaine to make a  $\frac{1}{8}$  per cent solution is sufficient to control the rather severe burning experienced during the actual injection of the quinine and urea hydrochloride. Immediate relief is usually experienced, and may last from three to twelve months. Permanent cure is never expected.

It would be useless to list the innumerable salves and ointments that have been advocated. They are, at best, palliative, and do not reach the fundamental trouble.

In my own treatment of these patients, a meticulous visual examination of the entire length of the anal canal and lower rectum is made for the discovery of the possible cause of an abnormal irritative discharge. Treatment is then instituted for the correction of the local lesion. In the majority of cases surgical correction is necessary, although in some cases the injection of internal hæmorrhoids or the non-surgical treatment of a cryptitis may be adequate. In certain cases, where the patient is not willing to await the healing of the operative wound for relief, subcutaneous injection of one-third of 1 per cent of quinine and urea hydrochloride may be employed for immediate relief, depending on correction of the pathological condition for permanent cure.

In 304 patients seen in the proctological clinic from September, 1931, to July, 1932, 152, or exactly 50 per cent, have suffered from localized anal itching. Of the other 152 patients, twenty-nine were seen for various disturbances not involving the anorectal region, which was found to be normal. Therefore, of 275 patients with anorectal disease, 54 per cent complained of anal itching. This serves to point out the frequency of this symptom in association with anorectal disease. A definite local cause was found to account for the pruritus in every one of the 152 cases except the very first case registered in the clinic. Inexperience and momentary enthusiasm for the mycotic theory of etiology resulted in failure to recognize the true local cause. A desire to check up on this patient has been thwarted by her return to Germany.

Space does not permit consideration of the detailed findings in each of the

152 cases which are contained in this record. The various local causes found include all those previously described.

Treatment was undertaken in only sixty-three of the 152 cases. The majority of those not having treatment were unable to obtain the funds requisite for a few days' stay in the hospital for necessary operative procedures. Four who were told that operative measures would be necessary for cure were given palliative treatment by injection of hæmorrhoids because of their inability to finance an operation. All four were markedly improved after the injection of large eroded internal hæmorrhoids. Complete relief in these patients depends, however, upon the correction of mechanical factors not amenable to injection therapy. Two patients had eroded hæmorrhoidal masses located entirely above the mucocutaneous line, which were prolapsing into the upper end of the anal canal. Injection treatment gave these patients complete relief for three and eight months. Their hæmorrhoids then recurred, as did their pruritus. Both patients had been told at the time of their original treatment that injection was not a cure for their hæmorrhoids. Both are now anxious to obtain more permanent relief by hæmorrhoidectomy. Two patients were treated for a considerable length of time on the supposition that mycotic infection was responsible, definite local pathological conditions within the anal canal being found at the original examination but ignored. Treatment was not satisfactory, and the necessary operative measures have not yet been undertaken. This leaves fifty-two patients in whom treatment has been completed. Of these, fifty-two, or 100 per cent, have enjoyed complete and absolute relief from their pruritus, without recurrence, and without the use of analgesic ointments or the employment of the various nerve-cutting or nerve-blocking procedures which may give temporary relief. The one exception to this was a man in whom subcutaneous injection of one-third of 1 per cent quinine and urea hydrochloride was done to give immediate relief for a very severe itching. His hæmorrhoids were then treated. The relatively brief period of relief in many of these cases prohibits dogmatic assertion of permanent cure, but their relief should endure just as long as there is no recurrence of the original local pathological condition.

In summary, our experience would seem to justify the statement that for every case of pruritus ani there is a definite local cause, detectable by proper examination, and amenable to proper treatment.

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# NON-SPECIFIC GRANULOMATA OF THE INTESTINES\*

(INFLAMMATORY TUMORS AND STRICTURES OF THE BOWEL)

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DURING the past few years we have encountered cases in increasing frequency which clinically and radiologically gave the impression of tumor or tuberculosis of the bowel. The appearance of the bowel at operation likewise was usually considered to be either that of hyperplastic tuberculosis or of malignant disease. Examination of the resected specimens, however, failed to substantiate such a view. No evidence of specific disease, such as tuberculosis, syphilis or actinomycosis could be found. Amoebic disease of the bowel was excluded on study of the microscopical sections and of the stool, also by the inefficacy of emetin therapy in suspected cases. Carcinoma, lymphosarcoma, and Hodgkin's disease were definitely excluded. In a few of these cases the condition was evidently secondary to diverticulitis. Aside from these, a large heterogeneous group of cases remained, differing from one another etiologically, but with certain common clinical and pathological findings. These cases, showing various degrees of chronic productive inflammation in different stages of healing, have long been known to English as well as continental surgeons. In 1921, Tietze<sup>1</sup> published a thorough resumé of the subject with a very complete bibliography. In 1923, Wilensky and Moschcowitz<sup>2</sup> reported four cases collected from various institutions under the designation "Non-Specific Granuloma of the Intestine," perhaps the most useful classification from the standpoint of the underlying pathology. Mock<sup>3</sup> recently reported a series of cases using practically the same designation. Clinically, these cases manifest themselves either by the development of palpable masses or by symptoms pointing to stricture of the bowel with ulceration. They may, therefore, with propriety, also be designated as non-specific inflammatory tumors and strictures of the bowel.

Both the intestine and its peritoneal covering are known to possess remarkable powers of resistance to infection and inflammatory lesions within them show a striking tendency to undergo resolution. Moreover, the intestinal mucosa in itself possesses marked regenerative power.<sup>4</sup> Surgeons have frequently recorded the amazing rapidity and completeness with which huge inflammatory exudates and masses may disappear from the abdomen. Very extensive disease or injury of the mucosa may heal without permanent scarring resulting. In some instances, however, following infection or injury, *restitutio ad integrum* does not occur. The persistence of infection or other

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\* Presented before the American Gastro-Enterological Association in May, 1932. The section on Localized Ileitis represents a joint study with Dr Burrill B Crohn.

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irritating factor or the inability of the tissues to overcome them, results in a series of reparative and destructive processes which lead ultimately to the formation of either hypertrophic peri-intestinal masses or extensive intramural hypertrophic ulcerative and stenosing lesions or combinations of both

Histological study of the various types of lesions shows merely evidences of various degrees and stages of acute and chronic inflammation with infiltration by lymphocytes, polymorphonuclear leucocytes, plasma cells and mast cells together with varying degrees of fibroblastic proliferation and often degenerative changes. In some of the peri-intestinal lesions there is often considerable hyalinization and calcification and even early bone formation has been encountered

The presence of giant cells is a common finding. We believe that these are of only accidental significance and are due to the presence of particles of non-absorbable vegetable matter which have become incorporated within the lesion as a result of deep ulceration, remaining entrapped within the healing tissues. Wilensky and Moschcowitz reported the presence of certain large cells in the microscopical sections of one of their cases. By means of special methods of staining, Doctor Antopol has been able to demonstrate in a few of our cases cells or groups of cells which are, in all probability, vegetable cells and around which giant cells are usually present. We have found them in the serous and sub-serous layers of the bowel, as well as within the submucosa, which may be an indication of their power to traverse the bowel wall through lymphatic channels. Being non-absorbable, they become encapsulated by foreign body giant cells. In the serosa they give rise to little nodules which can be differentiated grossly with great difficulty from miliary tubercles. Similarly foreign body tubercles have been produced experimentally by the introduction of emulsions containing vegetable matter into the peritoneal cavity<sup>5, 6, 9</sup>. The presence of vegetable cells is of two-fold importance, by their irritant action they may be a contributing factor in producing the marked hyperplastic fibrosis seen in some cases, in addition, they are probably responsible for the confusion of these non-specific lesions with tuberculosis, due to their stimulating the production of giant cells.

The following is based on a study of fifty-two cases which have been observed and operated upon, most of them at the Mount Sinai Hospital in the Surgical Service of Dr. A. A. Berg during the past ten years. Only cases\* in which resection was performed or specimens obtained are considered. The microscopical sections were restudied with the invaluable aid of Dr. Paul Klemperer in order to settle certain questionable points. An accurate etiological or pathological classification is at present impossible. We submit the following classification, therefore, fully conscious of its defects and overlappings, but pleading in its favor a certain degree of clinical utility.

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\* Cases of sigmoid diverticulitis or cases with lesions situated distally to the recto-sigmoid junction are not included. Two cases of ulcerative jejunitis near the fossa of Treitz have also been excluded from this study.

It is our plan to discuss each group and report in short abstracts some of the typical cases

- (1) Extra or peri-intestinal granulomata secondary to sealed-off perforations of the bowel
- (2) Granulomata secondary to known vascular disturbances of the gut
- (3) Localized hypertrophic ulcerative stenosis of the terminal ileum (Regional ileitis )
- (4) Localized hypertrophic colitis with or without low-grade generalized colitis
- (5) Simple penetrating ulcers of the colon
- (6) Lesions secondary to inflammation of the appendages of the bowel such as appendicitis diverticulitis, typhilitis

(I) LESIONS IN WHICH THE INFLAMMATORY REACTION IS MAINLY EXTRA- OR PERI-INTESTINAL AND WHICH ARE SECONDARY TO SEALED-OFF PERFORATIONS OF THE BOWEL

As a response to a slowly perforating lesion of the intestine that has become sealed off by omental, parietal or visceral adhesions, large inflammatory masses with very little or no pus formation may develop. These are intimately adherent to the serosa and subserosal tissues but do not actually involve the submucosal and muscular layers of the gut. A typical example is the lesion resulting from perforation of the colon by foreign bodies, such as fishbones. Usually, this accident results in the formation of a localized intra-abdominal abscess. In some instances, however, possibly due to a slow rate of perforation, the inflammatory reaction is chiefly productive. As a result of the continued presence of a penetrating foreign body and the low-grade infection resulting a marked hypertrophic inflammatory reaction takes place in the pericolic and subserous layers of tissue and both clinically and at the operating table may give the impression of being a colonic neoplasm. Three of our cases were operated upon with a previous clinical diagnosis of malignant neoplasm but were recognized as inflammatory tumors at the time of operation and foreign bodies sought for and found. Perforative lesions, from whatever cause, may involve the omentum with the development of a large omental mass of tissue with areas of necrosis and xanthomatous change, firmer fibrotic masses, areas of calcification or discrete encapsulated miliary abscesses. The lesion in the wall of the gut may be minimal.

An exceedingly interesting group are those cases in which a pseudotumor of the abdomen wall itself develops as a result of a perforative lesion becoming sealed off by the anterior parietes. In two such cases, foreign bodies (fish-bone, toothpick) were found in the centre of a large firm tumor mass involving the rectus muscle and peritoneal tissue. Each of these tumors had been excised because of a diagnosis of sarcoma of the abdominal wall. The opposite surface of each of these masses was densely adherent to the omentum but there was no evidence of adherent bowel. In two other

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cases in which the same pre-operative diagnosis of sarcoma was made adherent gut was found on the deep side of the mass, a perforation apparently having been sealed off by the parietal peritoneum. The "tumors" were found to be œdematous, granulomatous lesions involving the parietal peritoneum and the pro-peritoneal cellular tissue.

A total of ten cases\* makes up this group, five of them definitely due to foreign body. In three cases, the inflammatory mass was mainly in the serosal and subserosal layers of one of the flexures of the colon. In two instances the mass was mainly omental, the original site of the perforation being in the transverse colon in one instance and in the small intestine in the other. In four cases the main mass of granulomatous tissue lay in the abdominal parietes. In one instance it was chiefly perivesical.

Clinically these cases were characterized by the development of a palpable mass without symptoms of obstruction or ulceration. Because of the lack of intramural involvement of the bowel, the barium meal or enema usually showed no abnormalities. Occasionally, a persistent spasm of the bowel adjacent to the lesion was encountered and gave the impression of a filling defect. At operation these tumors were not found to encroach upon the intestinal lumen, and intra-intestinal irregularities or ulcerations were absent. This point is of use in differentiating densely adherent peri-intestinal inflammatory masses from neoplasm or from inflammatory diseases which actually involve the bowel wall.

### (II) LESIONS SECONDARY TO KNOWN VASCULAR DISTURBANCES OF THE BOWEL

The most striking example of this type of lesion that we have encountered is the stenotic involvement of the bowel which occurs when badly compromised but viable gut has been replaced following operation for strangulated hernia<sup>11</sup>. In these cases there is permanent vascular injury affecting the intramural vessels of the bowel. Vascularization through collateral anastomoses is sufficient to prevent necrosis of the muscular and fibrous layers of the bowel. It is, however, insufficient to permit the usual and very active regeneration of the mucosa. Ulcerative lesions of the mucous membrane ensue followed by secondary infection and the gradual production of severe grades of cicatricial stenosis of the intestinal lumen. Five such cases have been encountered in this series. All were of the type of a tubular stenosis, *i e*, stenosis involving an entire segment of bowel corresponding to the extent of previous strangulation. Cases of narrow annular stricture corresponding to the site of constriction at the neck of a hernial sac have been reported in the literature. In this series we observed one annular stricture in which a loop of gut had been caught under an encircling band of omentum. Small mesen-

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\* The large group of cases with marked productive pericecal changes due to appendicitis and perisigmoidal inflammatory masses from sigmoid diverticulitis also belong in this group and are much more common than any of the other types of lesions noted. They are so well known, however, that they have not been especially studied or included in the enumeration of this group.

teric tears have also been reported as causing similar stenosis and through a like mechanism

The symptoms were those of gradually increasing subacute intestinal obstruction, the ulcerative phase apparently passed by unnoticed. The symptoms of obstruction appeared anywhere from two weeks to six months following the strangulation. Short-circuiting entero-anastomosis afforded relief of symptoms in four cases, resection in one. One patient came to autopsy without operation.

In these cases we have definite evidence from the history and findings at the primary operation that there had been an extensive vascular insult. How large a rôle the vascular mechanism plays in cases where the causal connection is not so clear cut is difficult to say. Although not susceptible of proof, the possibility must be borne in mind that such conditions as repeated, self-reducing intussusceptions or recurrent partial volvulus especially at the ileocecal angle may be responsible for certain chronic inflammatory lesions. It must be emphasized that the end stages of a lesion in which primary vascular insufficiency produced necrosis and secondary infection of the bowel resemble in most respects those in which a primary infectious agent has produced secondary and thrombotic and degenerative changes.

### (III) HYPERTROPHIC ULCERATIVE STENOSIS OF THE TERMINAL ILEUM (Regional ileitis)

In this group of cases the terminal ileum was the seat of the lesion which was especially marked at the ileocecal valve, usually terminating abruptly on the ileal side of the valve. Proximally, the lesion diminished in severity, the signs of the disease being rarely found farther than twelve to fifteen inches from the ileocecal junction. We have no clue to its etiology but observation of various stages of the disease process in different patients leads us to believe that the following are the steps in its development. The primary stage, we believe, occurs in the form of multiple oval or lenticular ulcerations in the mucosa of the mesenteric side of the bowel. We have found this lesion on a number of occasions proximal to the main hypertrophic mass and separated from it by normal appearing mucosa. As the disease progresses it is characterized by two main features, first, a marked tendency to perforation, and second, an excessive proliferative reaction in the submucosa. The end stage of the process, the one most frequently encountered, is manifested by the conversion of the terminal ileum into a thickened, rigid, hose-like tube (Figs 1 and 2). When opened, the normal transverse intestinal folds in the terminal portion of the ileum are seen to be in part destroyed and in part flattened and broken up into polypoid masses. A row of linear ulcerations in the mucosa overlying the mesenteric border is practically a constant finding. In places, especially near the cæcum, the mucosa is almost completely atrophic and there may be papillary excrescences, especially along the margins of the ileocecal valve. The submucosa is enormously thickened and contributes to the marked diminution in the calibre of the lumen. Perforation

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may occur after adhesion of two loops of bowel or between the leaves of the mesentery, which with the enlarged glands gives rise to fairly large masses. The purulent exudate may force its way through loose cellular tissues forming secondary fistulous communications with the cæcum or colon. At times the perforation occurs into the peritoneal cavity with formation of an intra-peritoneal abscess. Drainage of these abscesses results in the formation of intractable fistulæ. These patients present themselves in four different clinical pictures.

(1) *Symptoms Simulating Those of Acute Appendicitis*—The first sign of the disease may be an attack which is impossible to differentiate clinically from appendicitis. At operation, however, it is at once noted that the terminal

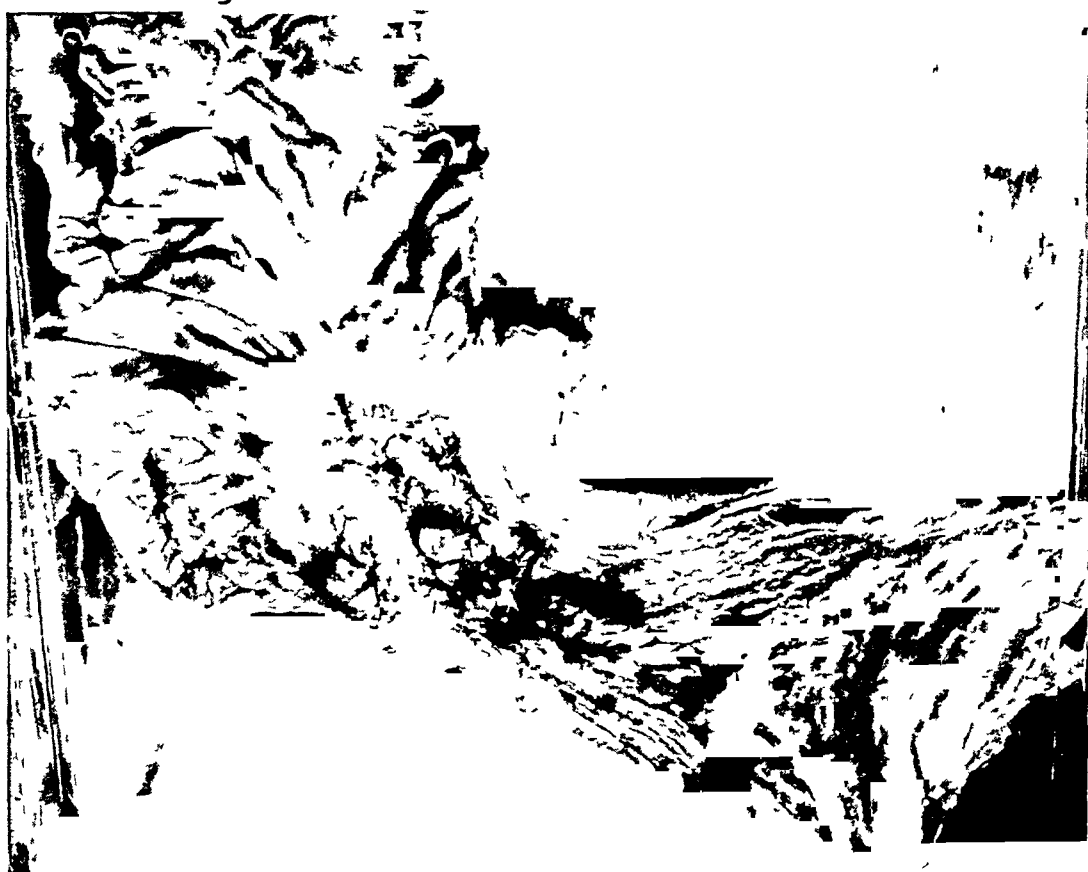


FIG. 1.—Non specific inflammatory stenosis of the terminal ileum. The inflammatory process ends rather abruptly at the ileocecal valve. The fibrotic thickening of the ileal wall is well shown, as are some polypoid mucosal masses.

ileum is soggy, œdematous and blotchy, and that there are numerous large succulent glands in the terminal mesentery. In no case of our series was resection performed in this stage of the disease so that we are ignorant of the underlying pathological changes present during this stage. A number of these patients were observed clinically as they passed into the more chronic phases of the disease. One case is symptom-free two years after exploration although X-ray shows definite narrowing in the terminal ileum\*.

Occasionally, these patients are admitted with an abscess already present. Drainage may result in the formation of a chronic fistula immediately after

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\* Since the completion of this article the patient has reappeared with recurrence of symptoms. Resection revealed a typical hypertrophic ileitis.

operation or there may be primary healing with secondary breaking down, occurring weeks or even months later

(2) *Symptoms of Ulcerative Enteritis*—There may be a low-grade diarrhoea, loss of flesh and strength, mild colicky pains and development of a secondary anaemia. This type is rather uncommon

(3) *Symptoms of Chronic Incomplete Obstruction of the Small Intestine*—This is the most common manifestation of the disease. The patient may have previously passed through one of the phases described above, but frequently the symptoms of obstruction appear without any previous history. Severe abdominal cramps, visible peristalsis, and borborygmi are the symptoms complained of most frequently. The duration of symptoms in this

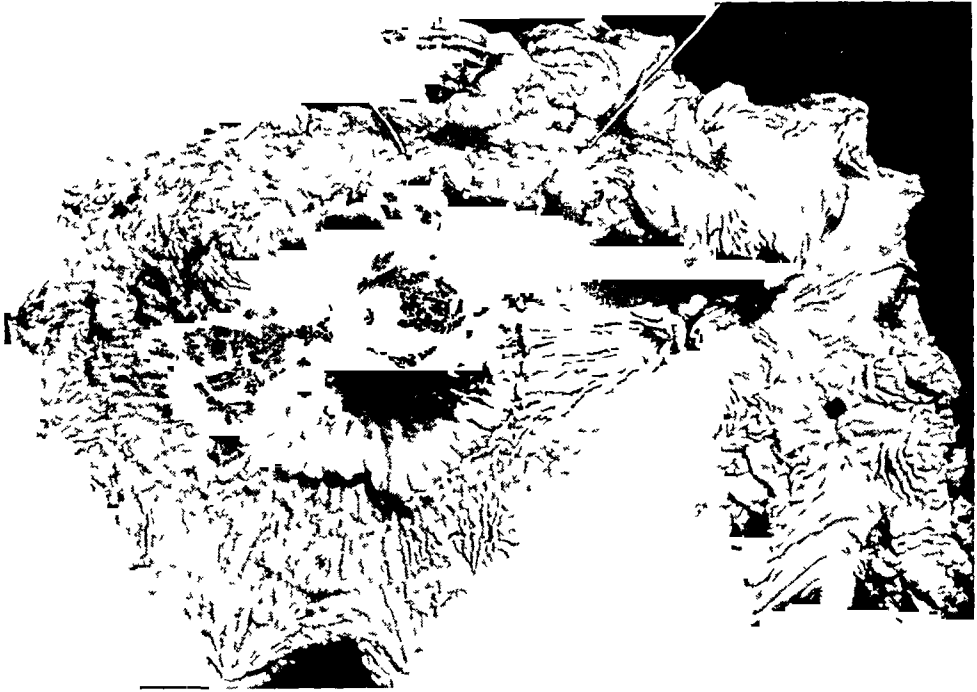


FIG. 2.—Non specific hypertrophic stenosis of the terminal ileum. The gradual transition from normal bowel to the extensively diseased portion is well shown. The probes pass into perforations on the mesenteric side of the bowel, which formed abscesses in terminal mesentery. At the hepatic flexure is the site of a perforation into the colon.

group varies from one to three years. At operation there is found the characteristic hose-like appearance of the ileum referred to above, frequently very densely adherent to or communicating with the cæcum, ascending colon or sigmoid. The occasional presence of small tubercle-like nodules may render differentiation from tuberculosis difficult. The nature of these foreign body tubercles has been discussed above.

A mass was palpable in every case of subacute or chronic type observed by us. Visible peristalsis was frequently noted. The barium enema, as a rule, showed no abnormality since the disease extends no farther than the ileocecal valve. However, pathological ileocolic or ileosigmoidal secondary communications may be formed and be reflected in the barium enema, this may lead to a false conception of the nature of the disease process. (Fig. 3)



Fig 3.—Barium enema showing irregularity near the hepatic flexure in a case of hypertrophic ileitis perforation into the colon. In such a case the X ray may be misleading and may give rise to the diagnosis of primary colonic disease

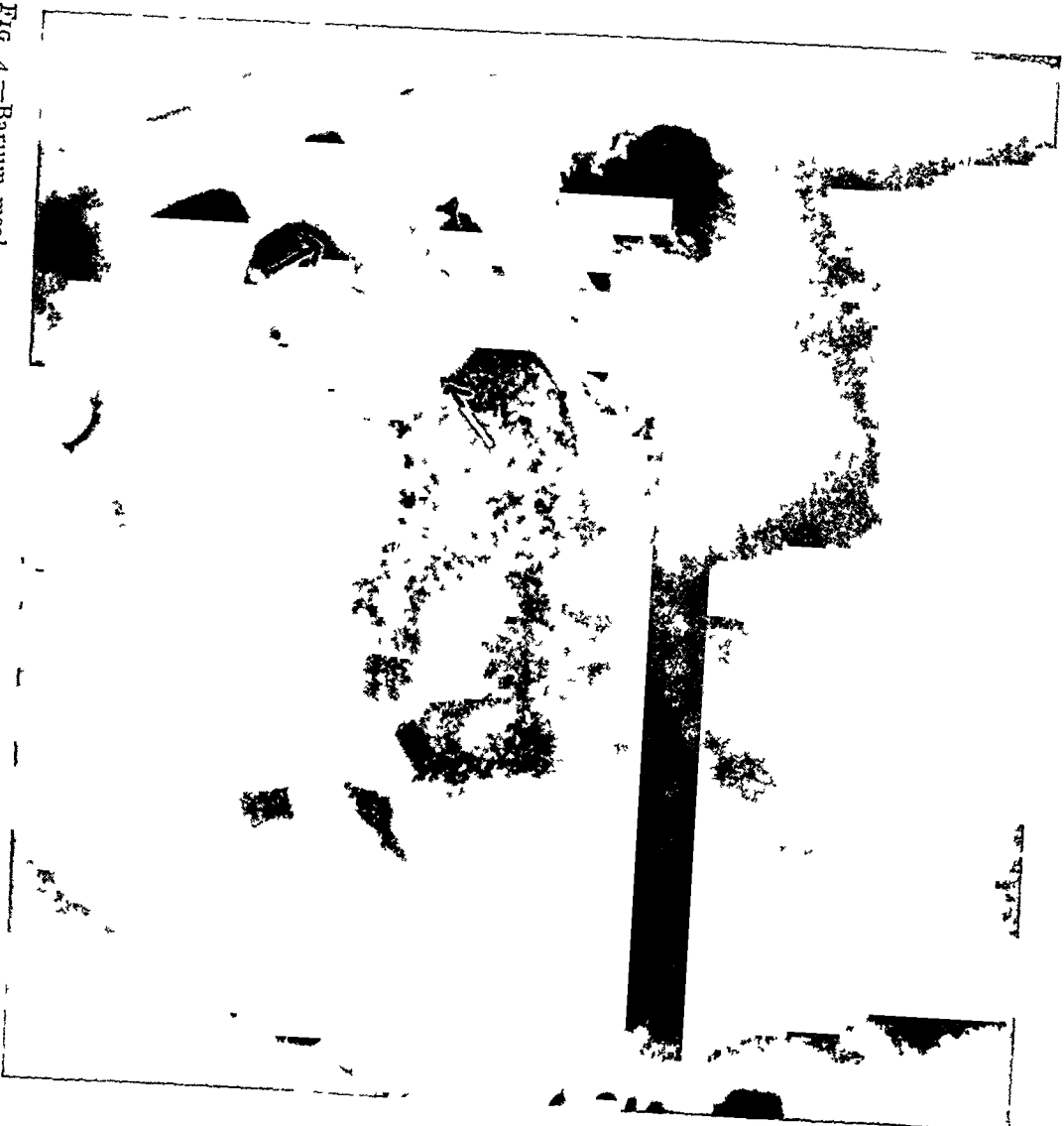


Fig 4.—Barium meal in a case of hypertrophic inflammation of the terminal ileum. Diseased portion appears as narrow cord like structure, indicated by the arrows



In two instances, barium meal demonstrated definite narrowing in the terminal ileum and ileal stasis (Fig 4) In most cases, however, no attempt was made to administer a barium meal because of the fear of precipitating complete obstruction

(4) *Chronic Intractable Fistulae*—These have resulted following drainage of intra-abdominal abscesses and have resisted attempts to produce closure by exposure of the internal opening and simple suture with enterostomy Cure has been achieved either by short-circuiting operations with exclusion of the involved loop or by resection of the diseased segment with enterocolostomy The findings at operation are those described under the chronic form of the disease with the added presence of extensive adhesions

There have been thirteen ileocecal resections in this group with one death Of the surviving twelve patients, one returned with an annular stricture a few inches proximal to the site of the original resection The other cases have done well We have only one *proved* case in which a previous short-circuiting operation had been performed, this patient later requiring resection An anastomosis had been made, apparently through diseased tissue, without division of the afferent ileal loop, with resultant implantation of the disease on the colonic side of the anastomosis There were four other patients, who, we believe, fall into this group in whom enterocolostomy with exclusion proved curative However, no specimens were removed from these patients and they are not definitely included in this series

*Relation to Appendicitis*—We have not been able to establish a relationship between appendicitis and the condition found in any of our cases Approximately half of these patients had been subjected to previous appendicectomies In some of them it had been noted at the time of the appendicectomy that distinct abnormalities were already present in the terminal ileum In the other patients the appendix was examined at the time of resection but no intrinsic abnormalities were found in it, except a severe peri-appendicitis

*Relation to Tuberculosis*—Careful study of the microscopical sections revealed no definite tubercles and no caseation necrosis, nor could tubercle bacilli be demonstrated In six instances, guinea-pig inoculation, inoculation into rabbits and into chickens were made and all failed to show evidence of any variety of tuberculosis Lowenstein cultures for tuberculosis were made in three instances and proved negative

It might be argued that evidences of tuberculosis would be difficult to find in tissue which has undergone fibrosis However, neither tubercles nor tubercle bacilli could be demonstrated even in the active ulcerative lesions found proximal to the main hypertrophic mass Even in the tubercle-like structures occasionally seen on the serosa, evidence of tuberculous infection could not be found

During the past ten years there have been only six cases of *localized hypertrophic ileocecal tuberculosis* resected surgically at the Mount Sinai Hospital as against eighteen of the non-specific variety\* There have been

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\* Well-defined active cases of pulmonary tuberculosis are not as a rule admitted to the hospital

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a number of instances of multiple tuberculous foci in the intestines found in the course of laparotomy. There have also been a few cases with active or advanced pulmonary tuberculosis showing X-ray evidence of involvement of the ileocecal region, in such instances operation was never resorted to.

To sum up our impressions of "primary" *localized hyperplastic ileocecal tuberculosis*, we would state that in our experience a surprising number of cases diagnosed as such clinically proved on microscopical examination to be non-tuberculous lesions, while those indubitably tuberculous proved to be unsuitable for operative resection because of the multiplicity of these lesions.

### (IV) LOCALIZED HYPERTROPHIC COLITIS

In addition to the localized palpable inflammatory mass, some of the cases at one time or another presented evidence of a low-grade general colitis, although much milder than the usual diffuse ulcerative type. Conversely, ulcerative colitis may affect predominantly or almost exclusively certain segments of gut, a fact which has been emphasized by Doctor Berg for years in discussing such cases on rounds, recently Barger<sup>7</sup> has reported a series of cases illustrating the same point. In most of the present cases there were no histogenological or sigmoidoscopical evidences of generalized colitis prior to the time of operation and the symptoms were attributed entirely to the localized colonic disease. In a few of these cases, persistence of symptoms after resection led to renewed investigation which in some instances showed evidences of mild general colitis which responded to medical therapy. In only one case did definite symptoms appear first in relation to a segment of gut other than that in which the hypertrophic mass ultimately developed (Case II).

Of this group the cæcum and ascending colon were the seat of the lesion five times, the rectosigmoid three times, the mid-sigmoid once, and the junction of the sigmoid and the descending colon three times. In the ascending colon, the hypertrophic disease usually extended upward until a few inches from the hepatic flexure. The mucosa showed occasionally large irregular ulcerated areas reaching one-half inch in diameter with areas of hypertrophic mucosa between them (Fig 5). In other cases the ulcers were smaller and were overshadowed by the bullous polypoid mucosa. Papillomatous and polypoid changes were common in the mucosa. The submucosa was moderately thickened and oedematous. The serosa was opaque, and there was marked thickening and hypertrophy of the subserosal fat both in the colon and mesocolon. The lymph-nodes in the ileocecal angle were enlarged. Numerous adhesions to the omentum and to surrounding loops of gut were found at operation.

In the sigmoid the pathological changes showed a greater cicatricial tendency with more limited involvement and relatively little ulceration. There was a greater tendency to development of strictures and papillary proliferation in the mucosa (Fig 4). Microscopically, merely various stages of

non-specific inflammation were seen. Careful search was made for amœbæ as well as tubercle bacilli, but no evidence of either was found.

Most of these patients had been ill for about six months before coming for operation. Abdominal pain, diarrhœa, and bloody stools were the most common complaints when the proximal colon was involved. When the sigmoid was involved, constipation and painful defecation were present. In some the symptoms were mainly those of obstruction. A mass was found



FIG. 5.—Hypertrophic colitis involving right colon. The extensive ulceration and polypoid hypertrophy of the mucosa are well shown. (Cf. Fig. 6.)

in every case either by abdominal palpation or by pelvic examination of the cul-de-sac. X-ray examination showed either an irregular filling defect or an area of narrowing in the involved segment. When the filling defect was unusually extensive, the presence of inflammatory disease rather than neoplastic disease seemed more likely (Figs 6, 7). In two cases, radiological evidence of co-existing colitis in addition to the presence of a local lesion was shown. On the whole, however, radiological differentiation from

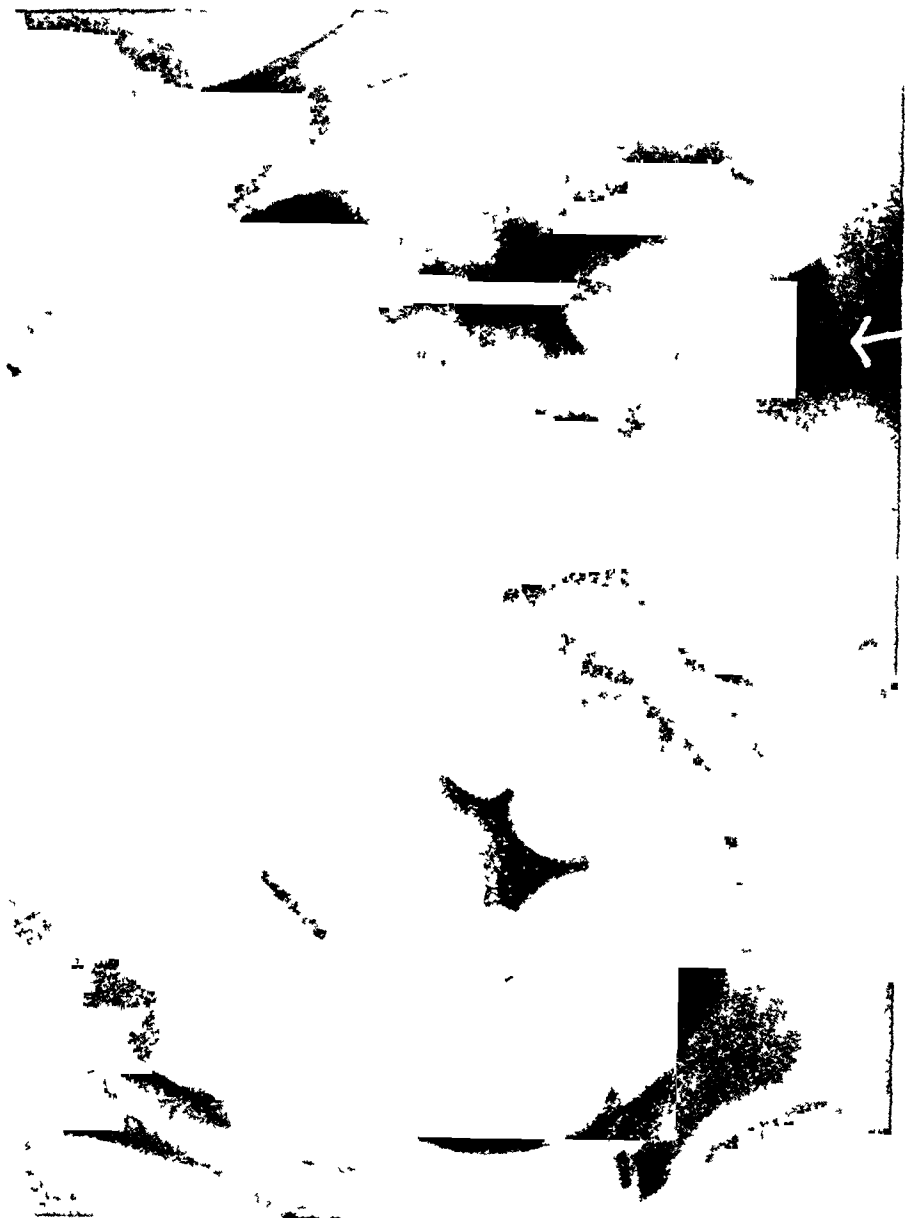


Fig 6—Case of localized hypertrophic ulcerative colitis—irregular filling defect involving ascending colon and hepatic flexure The left half of transverse colon is normal

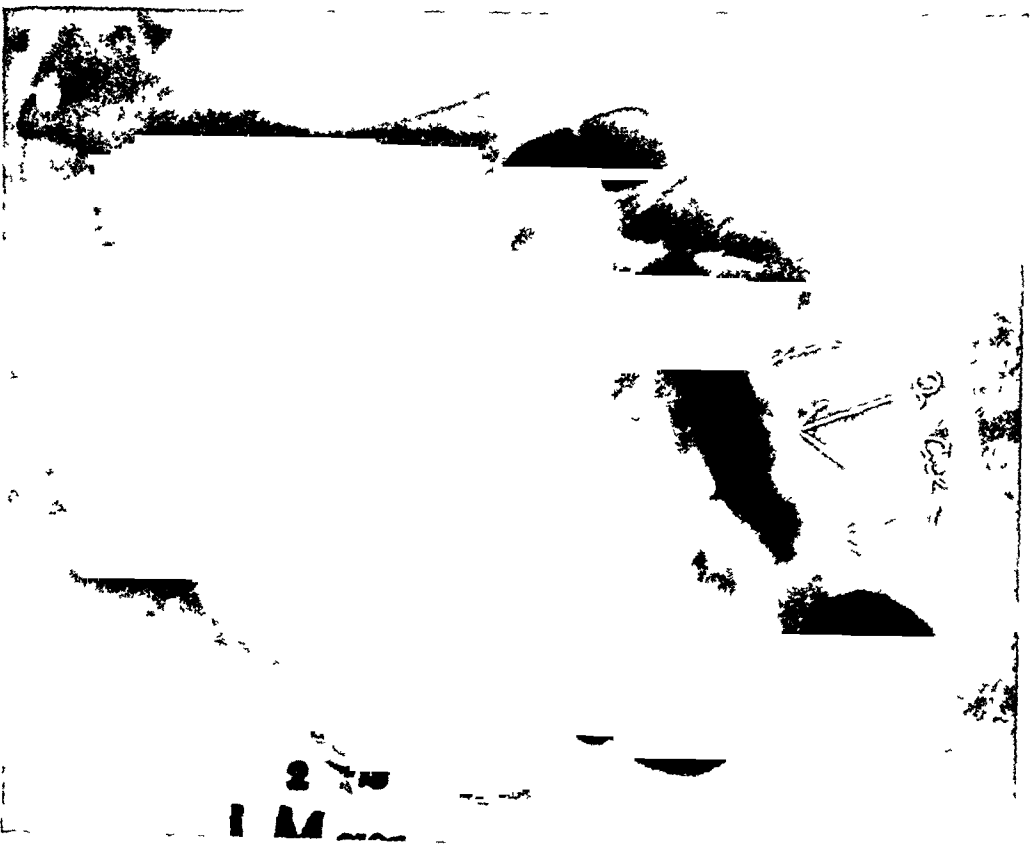


Fig 7—Barium enema Plate taken three years following resection, diseased area shown in Fig 6 For two years following resection the transverse colon remained normal Plate taken when patient had return of symptoms shows extension of diseased process to the splenic flexure

neoplasm or tuberculosis was not possible with certainty. The sigmoidoscope is of value in diagnosis not only for removing specimens for microscopical examination, but also for demonstrating multiple foci of disease.

At operation the determination of the exact nature of the pathological changes is again very difficult. Most of these cases were subjected to resection under the operative diagnosis of carcinoma or tuberculosis. Ulceration on the inside of the bowel, projection of papillary growths into the lumen and the presence of annular infiltration mimic neoplasm very closely.

In lesions involving the right side, ileocolic resection was performed five



FIG. 8—Filling defect in left transverse colon caused by narrow annular structure, probably from healing of simple penetrating ulcer of colon.

times with no mortality, no other procedure was adopted for this form of the disease. One of the patients had a mild recurrence of symptoms which cleared up under dietetic treatment.

In lesions involving the upper and midsigmoid, a Mikulicz operation was performed three times and an exclusion ileosigmoidostomy in one case. In another case, where, in addition to a rectosigmoid mass, definite evidence of generalized colitis could be demonstrated, a cecostomy was performed. Marked shrinkage in size of the mass and subsidence in severity of the symptoms followed. In two cases with localized lesions at the rectosigmoid junction, abdominoperineal resection with restitution of continuity by extra-

## GRANULOMATA OF INTESTINES

peritoneal pre-sacral anastomosis was performed according to the technic of Dr A A Berg. The only alternative in these cases would have been a left inguinal colostomy which would probably have resulted in complete stricture of the bowel below that site and precluded any later attempt at closure of the inguinal anus without a secondary and more difficult resection of the involved area. There were no mortalities in this group.

### (V) SIMPLE PENETRATING ULCERS OF THE COLON

This term is applied to a group of cases which show one or more clean-cut penetrating ulcers which look almost like punched-out peptic ulcers. It is apparently a purely local disease, the surrounding colon not appearing to be grossly diseased. In two cases, penetration had occurred through the colonic wall and had become sealed off by adhesions of omentum or epiploic appendices with the formation of rather firm inflammatory masses which gave the impression of being penetrating or perforation neoplasms. Both these lesions were situated in the ascending colon and were operated upon with the clinical diagnosis of acute appendicitis. At operation they were mistaken for carcinoma of the colon and were resected as such. Another manifestation, probably the same type of lesion, was encountered at autopsy in a patient who had experienced severe repeated hæmorrhages from the bowel, one of which finally proved fatal. Twelve centimetres from the rectum a group of punched-out ulcers was encountered. At the base of one of them was an arteriosclerotic vessel which had been eroded by the penetrating ulcers.

The end-result of the healing of such an ulcer or group of ulcers was probably at the basis of an annular stricture following the transverse colon of a young woman with no evidences of colonic disease. We have no conception of the underlying etiology of these lesions. It is possible that they are due to injuries by ingested foreign bodies. It is also a possibility that they are of vascular origin and are due to the blocking of a small vessel. They have been found not infrequently at autopsies performed at this hospital in a large variety of conditions, especially uræmia, vascular diseases and blood dyscrasias. They are usually not matters of surgical concern except when by perforation they give rise to a mass or in the process of healing result in stricture.

### (VI) INFLAMMATORY MASSES SECONDARY TO LESIONS OF APPENDAGES OF THE BOWEL (appendicitis, typhlitis, diverticulitis)

Probably the best known example of this variety of inflammatory mass is that which is secondary to *sigmoid diverticulitis*. This form has been so much discussed in recent years that we feel there is no reason for including it in the present study. We wish, however, to emphasize in passing that in addition to the large perisigmoidal inflammatory masses caused by perforation of a diverticulum or extension through it of infection from the lumen of the bowel, there is another and less common type. In the latter there is a gradually developing submucous inflammatory infiltration of the sigmoid as

well as an adhesive perisigmoiditis and the development of a considerable degree of intiamural fibrosis and hyperplasia with a considerable degree of stenosis. This type clinically and radiologically is extremely difficult to differentiate from malignant stenosing lesions of the sigmoid and even at operation differentiation may be impossible.

The relation of the appendix to the development of certain hyperplastic masses in the ileocecal region is a moot point. In many cases an unresolved appendicitis is undoubtedly responsible for the formation of a hyperplastic fibrotic mass, the so-called "*appendicitis fibrioplastica*" but this does not account for all the lesions found in this region. When the appendix is the source it is found buried in the cecal wall, or, as in one of our cases, in the terminal ileum, and forms part of the inflammatory mass. The extension of the inflammation in these cases is by contiguity, and, as might be expected, is mainly pericecal with involvement of the subserosal tissue. The submucous layer of the gut does not appear to be involved. Occasionally, tiny abscesses between the appendix and the cæcum will be uncovered when the former is mobilized, and fistulæ running into the cæcum may be found. This type of lesion is quite common, its true nature is usually appreciated and resection is rarely performed.

There is another and much rarer type of lesion, however, which may be called chronic typhlitis, in which the appendix, though thickened and indurated, lies free and non-adherent. Both appendix and cæcum show a marked submucous thickening, œdema and fibrosis. The lesion does not extend into the ascending colon or into the ileum except at the ileocecal valve, points which serve to differentiate it from the two other types of non-specific inflammatory disease encountered in this region which have been discussed above. Large masses of firm nodes are found in the ileocecal angle. Upon examination the pathological alterations involving the appendix and cæcum are seen to be continuous. If the route of spread were by direct extension from appendix into cæcum it would have to be through the contiguous submucous layers of the appendix and cæcum. However, clinically it is well known that inflammation of the appendix usually stops short of the extreme base even in the most virulent form of the disease. Doctor Klemperer, who at one time made a study of the extent of the basal involvement in acute appendicitis, was able to substantiate this clinical observation from his pathological study.

The question then arises whether the extension takes place into the cæcum from some unusual form of acute appendicitis involving the base or whether the ileocecal changes are primary, the appendix participating simply as a component portion of this segment of gut. We are inclined to believe that the type of chronic cecitis which shows extensive submucous intramural involvement but without evidences of mucosal ulceration is secondary to a partially resolved acute or chronic typhlitis.

There is no doubt about the existence of acute typhlitis as a clinical entity. On an active emergency service three or four such cases are encountered

every year. Clinically and on physical examination they present the picture of acute appendicitis. Operation, however, reveals a succulent, oedematous, inflammatory lesion without much peritoneal injection or fibrin deposition, involving the cæcum, the retroperitoneal tissue, the appendix and the ileocecal glands. The appendix does not appear to be more acutely involved than any of the adjacent tissues. Localized areas of induration from  $\frac{1}{2}$  inch to an inch in diameter may be present. In some of these cases the appendix and a lymph-node from the ileocecal angle were removed. On pathological examination these revealed only acute inflammatory hyperplasia. In one subacute case in which ileocecal resection was performed, a small ulcer was still present in the cæcum, the submucosal proliferative reaction was out of all proportion to the size of the ulcerative lesion. Most of the acute cases probably clear up, with or without operation. An especially severe case was recently encountered which came to post-mortem examination. The cæcum was found greenish-black and gangrenous. There were numerous cecal ulcerations, two of which had perforated. The appendix was gangrenous. Jennings<sup>8</sup> has recently called attention to this type of case.

In other cases repeated attacks result finally in the formation of a chronic submucous and subserous inflammatory infiltration. In such chronic cases there are no ulcerative, polypoid or papillary changes in the mucosa, the cecal wall is thickened and indurated and there are few adhesions present. A chronic lymphadenitis of the ileocecal lymph-nodes may contribute to the final pathological picture.

The symptom usually complained of is recurrent pain in the right lower quadrant without any history of blood in the stool, diarrhoea or constipation. At times the chief complaint is the presence of a mass. Radiologically, filling defects or irregularities in the cæcum are noted. The general condition of the patient is usually good, operation being mainly undertaken because of the presence of a mass. At operation differentiation from tuberculosis may be difficult and the cases subjected to resection have been operated on because of their similarity to that condition.

## SUMMARY

(1) A study is reported of fifty-two cases, exclusive of sigmoid diverticulitis, manifesting themselves clinically as tumors or strictures of the bowel.

(2) Clinically, radiologically and at operation these were usually regarded as malignancy or localized hyperplastic tuberculosis.

(3) Microscopical examination of the resected specimens showed various stages and degrees of acute and chronic inflammation with production of much fibrous tissue.

(4) No exact pathological or etiological classification is attempted. For clinical purposes the cases are divided into six groups, some of which overlap.

(a) Pericolonic or peri-intestinal granulomata due to sealed-off perforations.

(b) Intestinal stenosis due to known vascular lesions of the bowel.



- (c) Localized hypertrophic ulcerative ileitis
- (d) Localized hypertrophic colitis
- (e) Local penetrating ulcers of the colon
- (f) Granulomata secondary to inflammation of appendages or diverticula of the bowel

(5) The various groups are discussed and illustrative cases briefly reported

(6) In our material localized hyperplastic tuberculosis of the bowel in patients without evidence of pulmonary tuberculosis was less common than the non-specific variety of inflammatory lesion of the bowel

The authors wish to extend their gratitude to Dr A A Berg for so generously placing his extensive material at their disposal To Dr Paul Klemperer they are indebted for his invaluable and gracious assistance in studying the pathological phases of the conditions considered in this paper Thanks are due to Dr Louis Gross for numerous suggestions in the preparation of this paper and for putting the facilities of the laboratory at our disposal To Drs Richard Lewisohn, Harold Neuhoef, Edwin Beer and I C Rubin thanks are due for permission to use individual cases

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# ENTEROSTOMY IN ILEUS

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THE prognosis of acute intestinal obstruction has always been grave. In spite of the numerous clinical and important experimental studies made in this field, little of practical value has been added to lessen the staggering mortality.

The actual cause and mechanism of death in these cases is obscure and the fact that so much controversy exists emphasizes quite definitely that the problem is far from its ultimate solution. It is not within the province of the present study to discuss this phase of intestinal obstruction, for the recent papers of Ochsner<sup>1</sup> and Morton<sup>2</sup> have fully covered this material. It may suffice to state that the majority of investigators believe that toxins are produced in the obstructed bowel, which, when absorbed, cause the familiar clinical picture, but the exact nature, origin, composition and manner of absorption of these poisons is still undetermined. There is no doubt that cases of duodenal and jejunal obstruction run a more rapid and fatal course than those in which either the ileum or colon are affected. The loss of the secretions of the upper portion of the gastro-intestinal tract probably accounts for this. It is possible that the toxæmia in high obstructions may be increased by the absorption of duodenal and pancreatic secretions before they can be adequately detoxified by the cells of the ileum. It is also true that cases of obstruction complicated by a vascular strangulation are more toxic than those in which the obstruction is simple. But, undoubtedly, the most important factor influencing the prognosis is the element of time, for naturally the longer the period of obstruction, the greater the absorption of intestinal toxins, and the more marked the dehydration. Most workers are agreed that the characteristic dehydration and the concomitant chemical changes in the blood, the increase in the urea and non-protein nitrogen, the decrease in the plasma chlorides, and the rise in the carbon dioxide combining power, play very important rôles in the fatal cases of intestinal obstruction.

The clinical picture of either the mechanical or the paralytic variety of intestinal obstruction is quite similar and is usually evidenced by severe dehydration, abdominal distention with or without vomiting, the absence of bowel evacuations, and occasionally visible peristalsis. It is very important, however, to differentiate between these two varieties because the treatment is different.

The main basis of therapy in dynamic ileus must be the urgent relief of the obstruction with its toxæmia and the associated dehydration. An early diagnosis with immediate operation and the adequate supply of fluids administered orally, subcutaneously, intravenously and by rectum, answer these requirements.

Whenever possible, the anæsthesia employed should be spinal because it insures a complete abdominal relaxation which makes exposure simple, and the operation may be speedily performed with the minimum amount of trauma and shock. There is a group of cases in which the obstructed intestine remains dilated after the cause has been removed. The question naturally arises whether the immediate external drainage of the distended loops will diminish the degree of intestinal toxæmia and relieve intra-intestinal pressure. The operation of enterostomy has been used for years. When the shortcomings of ileostomy were recognized more than a decade ago, jejunostomy was enthusiastically recommended. High jejunostomy for a time was heralded in many clinics as an ideal method to effectively drain the lethal toxins originating in the duodenum. Theoretically, it should lessen the absorptions of intestinal poisons near the source of their origin. The arguments in favor of jejunostomy, however, seem to be mainly academic for any surgeon who has seen the rapid deterioration of unfortunate patients suffering from duodenal fistulæ, has little enthusiasm for the possible problem of a subsequent persistent high jejunal fistula. For even though fluids are adequately supplied to combat the dehydration caused by the loss of bile, duodenal and pancreatic secretions, death often occurs. In fact Haden and Orr<sup>3</sup> who have contributed much of value to the vast bibliography of intestinal obstruction have shown that in experimental high obstruction in dogs, a jejunostomy shortened the span of life. And while ileostomy itself did not prolong the lives of the animals, if this procedure was combined with hypodermoclysis, life was definitely prolonged.

Cases have been observed clinically in which a jejunostomy was performed to insure the immediate drainage of high intestinal toxins, but the life of the individual became so seriously menaced by subsequent dehydration, inanition and skin maceration, that the closure of the jejunal fistula was demanded.

Ileostomy in general and jejunostomy in particular have never been used extensively in the treatment of intestinal obstruction at Mount Sinai Hospital, New York. A study of the available material will show that jejunostomy has not demonstrated its superiority sufficiently to counterbalance the ill-results seen so often after its institution, and even ileostomy has been of such doubtful value that it should only be used in very carefully selected cases.

In a large series of cases of intestinal obstruction of various groups, enterostomy was done in only forty-one cases of the acute mechanical ileus and in twenty-one cases of paralytic obstruction. The causes of the ileus for which an enterostomy was performed are enumerated in Tables I and II respectively.

The mortality following enterostomy in the dynamic group averaged about 70 per cent, and in the adynamic, 80 per cent. Jejunostomy was done in eleven cases with a mortality of 73 per cent, and ileostomy in the remainder with a mortality of 74 per cent. This is a fearful mortality but it must not be forgotten that in the majority of cases, the period of obstruction had lasted from one to six days, and in many instances, enterostomy was done as a pro-

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cedure of last resort and performed in a desperate endeavor to stave off impending dissolution

TABLE I

*Cases of Mechanical Ileus in Which Enterostomy Was Performed*

Cause of Obstruction	Number	Living	Dead	Percentage Mortality
Post-operative adhesions				
old	15	3	12	
Tumors of the large bowel	8	3	5	
Acute intussusception	7	0	7	
Strangulated hernia	4	0	4	
Post-operative adhesions following				
recent appendectomy	4	4	0	
Inflammatory ileal stricture	2	1	1	
Pelvic peritonitis following carcinoma of bladder	1	0	1	
Pelvic peritonitis following diverticulum of bladder	1	1	0	
Pelvic peritonitis following appendectomy	2	2	0	
	44	14	30	70%

The Witzel technic of enterostomy was performed in almost all cases. While it is a simple operation, it requires great care and careful attention to the toilet of the peritoneum. The insertion of a rubber tube into a friable, dilated intestine filled with highly toxic material, may result in the tearing of the bowel with inevitable spilling and a generalized contamination unless the procedure is gently performed. The cuff of the enterostomy tube must be securely fixed to the surrounding skin for otherwise the tube may be inadvertently dislodged causing intraperitoneal leakage. This unfortunate accident happened twice in this series. In another case the indwelling tube caused pressure against the bowel wall resulting in a perforation into the free peritoneal cavity. After a certain length of time, leakage occurs about the tube and the care of the surrounding skin taxes the ingenuity of most resourceful surgeons. The automatic closure of the enterostomy following the withdrawal of the tube does not happen as frequently as a theoretical consideration of the Witzel valve might lead one to believe. The enteric fistula in the sixteen cases which survived did not close immediately or spontaneously upon the withdrawal of the tube. The enterostomy often took weeks to close, and in eight operations for closure were necessary at intervals from fourteen to eighty days following intestinal drainage. The operative closure of any fistula is not a simple problem. It is not always successful and in two cases a recurrence took place. Death resulted in another from peritonitis due to a non-competent anastomosis following an enterorrhaphy.

It might be advisable at this point to turn from a general discussion to a consideration of the value of enterostomy in certain selected groups of cases in which it was instituted.

The first group of cases which illustrates the value of enterostomy in a mechanical type of obstruction consists of 135 cases of acute ileus due to old post-operative adhesions. The operative procedure in the majority of 120 cases was simple division of the obstructing band although in a few, an additional entero-enterostomy was performed.

Twenty-four of this number died, a mortality of about 20 per cent. Enterostomy was added as an additional procedure in fifteen cases, or 11 per cent of the total number. The average period of obstruction in these cases was eighty hours. The mortality in this enterostomized group was 80 per cent.

Enterostomy was performed in twelve at the time of the primary operation after the obstructing band had been removed, and in three as a secondary procedure after the signs of obstruction still persisted after the first operation. Eight succumbed in the primary group, four from the effects of the paralytic ileus, two from peritonitis, one from shock, and one from pneumonia. All died in the secondary group from a persistent paralytic ileus. In four of the eleven patients who died, the intestinal drainage from the enterostomy tube was charted as satisfactory. But in spite of this death resulted. These patients had probably absorbed the lethal dose of intestinal toxin prior to the first operation or subsequent to the second, and, therefore, were marked for death regardless of any surgical interference.

TABLE II  
*Cases of Paralytic Ileus in Which Enterostomy Was Performed*

Type	Number	Living	Dead	Percentage Mortality
Acute appendicitis with general peritonitis	9	2	7	
Perforated gastroduodenal ulcer with general peritonitis	4	0	4	
Perforated gall-bladder with bile peritonitis	2	0	2	
Perforated typhoid ulcer with general peritonitis	2	1	1	
Perforated carcinoma of stomach with general peritonitis	1	0	1	
Perforated diverticulum of sigmoid with general peritonitis	1	0	1	
Perforated Meckel's diverticulum with general peritonitis	1	0	1	
Mesenteric thrombosis	1	0	1	
	21	3	18	85%

The second group of cases illustrative of the value of enterostomy in mechanical obstruction consists of 278 strangulated hernias of various kinds, many of which were associated with vascular compromise. The obstruction was relieved at a very early period in 199. These were relatively non-toxic cases in which the obstruction was simple and without vascular strangulation. The mortality of this group was 13 per cent. But the mortality climbed to

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29 per cent in forty-seven cases in which operation was deferred until the obstructed bowel exhibited those characteristic changes dependent upon vascular strangulation. The mortality arose to 40 per cent in twenty-two cases in which a frank gangrene of the obstructed intestinal loop necessitated resection. The high death rates in these two aforementioned groups were undoubtedly attributable to the more severe toxæmia which invariably accompanies any obstruction complicated by vascular strangulation. It is in this type of severely toxic case that enterostomy should be indicated. For if the immediate drainage of intestinal toxins is of any consequence, it should be evidenced here. Immediate drainage of the highly toxic intestinal content should tide the patient over the critical period until peristalsis has been normally resumed. Enterostomy was done in four cases and all these terminated fatally. The number is small and it is difficult to draw any conclusions. But it does seem logical to conclude that the cases operated on early are those of simple obstruction in which the minimal amount of intestinal toxin, if any, has been absorbed. Therefore, the degree of intestinal paresis is slight and the muscular tone of the intestinal wall is good. Normal peristalsis is soon resumed with a free evacuation of the bowel. On the other hand, cases of intestinal obstruction operated late are those complicated by vascular strangulation with its incident and concomitant changes. Larger quantities and more toxic secretions and excretions are absorbed from the dilated necrotized intestine. Intestinal paresis is marked, muscular tone is lacking, and the peristalsis is practically nil. This paralytic condition may persist for a varying period after the obstruction has been relieved. What reason is there to believe that a paralyzed bowel will drain better if an artificial drainage tract is established? It will drain only locally, and therefore, does little to relieve the general intra-intestinal pressure and toxæmia. The fistula may drain later when intestinal peristalsis returns, but at that time the lethal dose of intestinal toxins may have been absorbed, or peristalsis has returned to such a degree that enemata have become effectual. There is little need for an enterostomy at this time. One group of cases of intestinal obstruction definitely benefited by enterostomy were those caused by tumors of the large bowel. While many surgeons prefer a cæcostomy in these cases, a low ileostomy offered immediate relief from the obstruction in three of the seven cases in which a preliminary emergency drainage procedure was done. When the condition of the patients had improved sufficiently, the more radical procedure of colonic resection was subsequently performed.

It might be instructive to review the frequency of enterostomy in cases of acute appendicitis. Intestinal obstruction may occur soon after appendicectomy due either to recent intraperitoneal adhesions or bands, or pelvic exudate, or the result of paralytic ileus. Two thousand, eight hundred and forty-one cases were operated on during a ten-year period. The type of appendicitis and the frequency of enterostomy for intestinal obstruction is given in Table III.

TABLE III

Type	No	Mortality	Enterostomy as a Secondary Procedure	Died After Enterostomy
Catarrhal appendicitis	82	95	0	0
Acute gangrenous appendicitis	973	31	2	1
Acute appendicitis with abscess	665	54	2	0
Acute appendicitis with generalized peritonitis	359	20	11	6

Enterostomy was performed in fifteen cases of acute appendicitis. Six were performed because of a secondary mechanical obstruction occurring soon after appendectomy. Two of these were caused by pelvic exudation in which jejunostomy alone was done, and four were caused by recent adhesions in which obstructing bands were divided and an ileostomy performed. All six cases recovered. The remaining nine cases for which enterostomy was instituted were due to a paralytic ileus, only two of these patients recovered.

Enterostomy in the paralytic variety of intestinal obstruction has been practically discarded. Its usefulness can best be evaluated reviewing the twenty-one cases enumerated in Table II in which an enterostomy was performed for paralytic ileus incident to a general peritonitis. The mortality was 85 per cent.

Most surgeons are agreed that external intestinal drainage accomplishes little when the peritoneum is diffusely inflamed, and the intestines bound together and kinked by adhesions are paralyzed and atonic. The dry enterostomy tube is the usual proof of the inadequacy of this procedure.

Enterostomy apparently has no indication in the treatment of adynamic ileus. The use of irritative enemas, turpentine stupes, the judicious administration of pituitrin, the maintenance of a water balance, and the use of the Levin tube are certainly more efficacious than external intestinal drainage. Satisfactory retrograde drainage of duodenal, pancreatic and biliary secretions has been accomplished without the aid of an external jejunal or ileal fistula by the intranasal introduction of the Levin gastric tube. When once inserted, it is usually well tolerated by the patient and may be left in the stomach for days. In this respect alone, it is far superior to the intermittent gastric lavage which taxes the strength of the debilitated patient. The Levin tube acts as an effective drain for the gastric and the refluxed intestinal contents, and acts prophylactically against a gastric dilatation. If drainage is sluggish, it can be aided by aspiration through the tube. The danger of an alkalosis from the loss of gastric secretions can be guarded against by the liberal intravenous administration of saline. In addition, the thirst of patients is psychically relieved for they may drink liberally inasmuch as the ingested fluid is automatically withdrawn by syphonage. When the clinical condition of the patient improves, as may be determined by the character and amount of gastric return, the diminution of abdominal distention, and the satisfactory return

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from enemata, the Levin tube may be intermittently clamped. It may be withdrawn as soon as the normal intestinal flow is established.

**SUMMARY AND CONCLUSIONS**—It would appear from this study of forty-four cases of acute mechanical ileus in which an enterostomy was done, that it was of benefit in a selected group of cases only.

One group consisted of those cases of obstruction due to localized inflammatory adhesions seen in pelvic exudates. The local infection would have been widely spread if an operative attempt had been made to free the obstruction at the site of origin. An enterostomy in these cases is logical as a make-shift procedure and can usually be performed in a fairly clean field above the point of obstruction. It will usually tide the patient over the acute stage of an obstruction until the infection has subsided sufficiently to allow a more thorough exploration subsequently, and occasionally it will be all that is necessary. Clinical experience will testify to its efficacy as an emergency procedure. This was successfully done in three cases of obstruction incident to pelvic peritonitis. As the infection subsided and the obstruction was automatically relieved, the normal intestinal passage was restored and the enterostomy closed spontaneously.

The other group of cases apparently aided by enterostomy are those due to obstructive tumors of the colon. While many prefer a cæcostomy, an ileostomy may offer temporary relief from the obstructive symptoms until the condition of the patient has improved sufficiently to permit subsequent colonic resections.

It is extremely doubtful, however, whether enterostomy is of benefit in other groups of cases in which the cause of obstruction has been relieved. Ileostomy as an additional procedure in relieving intestinal toxæmia has little to offer and jejunostomy less. In many of those cases which recovered, enterostomy seems to have been an added source of danger because of a persistently draining enteric fistula. In fact, at present, the high mortality of intestinal obstruction of mechanical origin can only hope to be lowered if the condition is diagnosed early. The cause of the obstruction must be actively relieved by immediate operation under spinal anæsthesia. The dehydration present should always be adequately relieved by the liberal administration of fluid.

Enterostomy has no indication in the paralytic type of ileus.

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# INTUSSUSCEPTION DUE TO INVAGINATED MECKEL'S DIVERTICULUM

REPORT OF TWO CASES WITH A STUDY OF 160 CASES COLLECTED  
FROM THE LITERATURE

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MECKEL'S diverticulum and intussusception are relatively common, but the combination is quite infrequent. Reports of two cases of this combination operated upon at the University of Chicago clinics in the past year are included in the present article. An attempt is made to formulate a clinical syndrome from an analysis of these two cases and from those reported in the literature.

REPORT OF CASES—CASE LXXII\*—U M, male infant, aged seven months, entered the hospital with bloody stools, vomiting, abdominal pain, and signs of intestinal obstruction of three days' duration. The patient was the first child in the family and his birth and feeding history were normal. He was entirely well and had no signs of abdominal distress except three weeks before the present illness. At that time he passed two bloody stools and was indefinitely ailing for a period of twenty-four hours, but recovered completely.

The present illness began suddenly with vomiting and bloody stools. These symptoms disappeared after the patient had received an enema. He seemed almost entirely well until about twelve hours before entrance when he again had vomiting and bloody stools and was apparently suffering great pain. There was no evidence that the pain was of a colicky type. The abdomen was markedly distended, there was no tumor palpable on either rectal or abdominal examination, there could be no certainty as to whether there was tenderness because of the child's age, and there was no rigidity. The temperature was 37.0° C, and the white blood count, 11,000. During fluoroscopic examination of the colon, the barium passed unhindered up to the splenic flexure where it stopped suddenly with the typical bulbous expansion with a cup-like depression in its centre suggestive of intussusception.

Operation was performed by Doctor Andrews three days after the onset and two hours after entrance to the hospital. A combination of novocaine locally and ethylene-ether as a general anæsthetic was used. No excessive free fluid was found in the peritoneal cavity. An intussusception was found with four inches of ileum prolapsed through the ileocaecal valve. This was reduced by expulsion and at the apex of the intussusceptum was found a Meckel's diverticulum about one centimetre in length. By squeezing the intestine, the diverticulum was everted and was so oedematous that it stayed everted. There was no gangrene and no further operative procedure was done. There was no tumor of the diverticulum. The abdomen was closed without drainage. The child is now well eleven months after operation.

CASE LXXIII—W P, male, aged five, entered the hospital with vomiting, colicky pains around the umbilicus, and absolute constipation of thirty-two hours' duration. The

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\* The numbers of this and of the following case correspond with those given in a tabular summary later in the article. Case LXXII has been previously reported by Doctor Andrews.

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patient was the third of several children and his birth and feeding history were normal. He was always well and there was no history of previous abdominal attacks.

The present illness began at 8 A.M. on January 5, 1932, with sudden onset of severe, cramp-like pain all over the abdomen, but somewhat localized to the region of the umbilicus. Some blood was returned from an enema, there was vomiting, and the white blood count was 16,500. The patient was given paregoric and slept well that night. The morning of January 6 the pains returned with increased intensity at five- to ten-minute intervals. Between the paroxysms there was comparative comfort. The colicky nature of the pains and their localization to the region of the umbilicus was more definite than on the preceding day. At 3 P.M. the patient was admitted to the hospital. No mass could be felt by abdominal or rectal examination. There was tenderness all over the abdomen, most marked in the right lower quadrant. There was no distention and no rigidity. The temperature was  $37.5^{\circ}\text{C}$ , pulse rate, 118, hæmoglobin 85 per cent, red cells, 4,800,000, and white cells, 13,500 with 60 per cent polymorphonuclears and 40 per cent mononuclears. The urine was normal.

Operation was performed by Doctor Andrews at 4.00 P.M., thirty-two hours after the onset and one hour after admission to the hospital. The anæsthetic was ethylene and ether. A right rectus incision was made and when the peritoneal cavity was opened, considerable serous fluid escaped. An ileocæcal intussusception about twenty-five centimetres long was found and easily reduced by expulsion and milking. At the apex of the intussusception was an inverted Meckel's diverticulum about four centimetres long. This was everted by squeezing the bowel and was gangrenous. The diverticulum was excised and the longitudinal opening on the antimesenteric surface of the bowel closed. The abdomen was closed without drainage. For three days the patient vomited considerably. Glucose in Ringer's solution and glucose alone were given subcutaneously and rectally. There was a spontaneous stool and gas on the third day. There was no vomiting after January 9, a dry diet being started on this day, and thereafter recovery was uneventful. The diverticulum showed no evidence of tumor and histological examination showed necrosis, especially of the mucous layer. The child is now well, three months after operation.

**SUMMARY OF LITERATURE**—The earliest known case of intussusception due to invaginated Meckel's diverticulum is the specimen placed in the St Bartholomew's Hospital Anatomical Museum in 1846. I am able to find 160 cases recorded in the literature. Cheyne<sup>19</sup> reviewed sixteen cases in 1904, Forgue and Riche,<sup>42</sup> thirty-four in 1907, Gray,<sup>49</sup> forty in 1908, Gross,<sup>51</sup> 40 in 1912, Kasemeyer,<sup>72</sup> forty-two in 1912, Hertzler and Gibson,<sup>61</sup> forty-five in 1913, Wellington,<sup>134</sup> fifty-nine in 1913, Lower,<sup>86</sup> fifty-two in 1925, and Kaspar,<sup>74</sup> seventy-two cases in 1925.

The cases reviewed in the present article are divided into two groups. Group I includes 114 cases with relatively complete individual case reports. On the basis of Group I, an analysis is made of the symptoms, course and treatment of intussusception due to invaginated Meckel's diverticulum. Group II includes forty-six cases with incomplete individual case reports and in the analysis of the literature this group is not considered so as not to distort the averages and percentages.

### REPORTED CASES GROUP I

Series of 114 cases of intussusception due to invaginated Meckel's diverticulum for which enough data are given to make them the basis of an analysis later in this article. In all the 114 cases, the following facts are tabulated: case number, author, date, age of patient in years, and all other factors listed in the following summation of the group. In

all instances where any of these facts are not mentioned in the case abstracts, data were not given concerning them in the original reports

*Age*—Average in 113 cases with data given on this point, thirteen years

*Sex*—In 105 cases with data given, eighty-three males and twenty-two females

Previous abdominal crises were present in forty-six out of sixty-seven cases with data given

Abdominal pain was present in ninety-seven out of ninety-eight cases with data given

Vomiting was present in eighty-two out of eighty-two cases with data given

Meteorism was present in forty-five out of sixty-nine cases with data given

Abdominal tenderness was present in forty-one out of fifty-four cases with data given

Abdominal rigidity was present in twenty out of forty-two cases with data given

Mass palpable per rectum was present in four out of thirty-seven cases with data given

Tumor in right lower quadrant was present in forty-one out of eighty-one cases with data given

Colic was present in fifty-two out of fifty-four cases with data given

Fever over 37.5° C was present in fifteen out of thirty-nine cases with data given

Blood was passed per rectum in forty-three out of seventy-seven cases with data given

Average duration of the present illness was 81.6 hours in eighty-eight cases with data given

Abdominal exudate was found in thirty-nine out of forty-three cases with data given

Diverticulum contained a tumor in twenty-six out of sixty-three cases with data given

Gangrene was present in thirty-nine out of seventy-one cases with data given

Diverticulum was reducible in fifty-four out of eighty-nine cases with data given

Resection of the diverticulum only was performed in thirty-nine out of 113 cases with data given

Resection of the bowel was performed in sixty-one out of 114 cases with data given

Recovery occurred in sixty-six out of 112 cases with data given

CASE I—Ingle,<sup>88</sup> 1888, age five months, pain, vomiting, meteorism, no tenderness, no tumor in right lower quadrant, melena, duration, five days, operation not permitted, death

CASE II—Weil and Frankel,<sup>133</sup> 1896, age four years, female, no previous attacks, present attack pain, vomiting, no meteorism, tenderness, no rigidity, tumor in right lower quadrant, temperature 37° C, melena, duration, thirty-six hours, operation abdominal exudate, diverticulum had no tumor, was gangrenous and was reducible, resection of bowel, death

CASE III—Ewald,<sup>38</sup> 1897, age forty-two years, female, several attacks of abdominal pain in past seven months, present attack pain of colicky type, vomiting, meteorism, no melena, diverticulum contained no tumor but was gangrenous, no operation, death

CASE IV—Kuttner,<sup>82</sup> 1898, age forty-nine years, female, acute attack eight months before, present attack pain, vomiting, meteorism, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, fever 39.2° C, no melena, duration, three days, operation abdominal exudate, diverticulum had no tumor, was gangrenous and not reducible, intestinal anastomosis only, no reduction of intussusception, death

CASE V—Haasler,<sup>60</sup> 1902, age thirty-five years, male, attack of abdominal pain one year before, present attack pain of colicky type, vomiting, meteorism, no tenderness, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, no melena, duration, seven days, operation abdominal exudate, diverticulum contained a tumor, was reducible, but not gangrenous, resection of bowel with colostomy and no anastomosis, death

CASE VI—Bize,<sup>6</sup> 1904, aged six years, female, no previous distress, present attack pain, vomiting, meteorism, tenderness, no tumor in right lower quadrant, fever 38° C, melena, duration, five days, operation abdominal exudate, diverticulum contained a tumor, was reducible, but not gangrenous, resection of diverticulum only, death

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CASE VII—Bousquet<sup>10</sup> 1904, age thirty-nine years, male, bloody stools with colic for four months, abdominal mass that disappeared two weeks before onset, present attack colicky pain, vomiting, meteorism, no tenderness, no rigidity, tumor in right lower quadrant, no fever, duration, two days, operation abdominal exudate, diverticulum contained a tumor, was not gangrenous, but was reducible, resection of diverticulum only recovery

CASE VIII—Rehn,<sup>112a</sup> 1904, aged thirty years, male, attacks of abdominal pain for months, present attack colicky pain, tumor in right lower quadrant, operation tumor of diverticulum, resection of bowel, recovery

CASE IX—Hirschsprung,<sup>68</sup> 1905, age three years, male, melena for three days, resection of bowel, death

CASE X—Richter,<sup>112</sup> 1906 age three years, male, no previous abdominal complaint except obstipation, present attack pain, vomiting, meteorism, no tumor in right lower quadrant, no mass felt per rectum, temperature 37.6° C, melena, duration, one day, operation diverticulum reducible resection of diverticulum only, death

CASE XI—Mothersole,<sup>101</sup> 1907, age six years, male, present attack pain, vomiting, tenderness, rigidity, no tumor in right lower quadrant, melena, duration, one day, operation diverticulum contained no tumor, was reducible and not gangrenous, only the diverticulum was invaginated, the ileum not forming part of the intussusceptum, resection of the diverticulum only, recovery

CASE XII—Gruson,<sup>52</sup> 1907, age twenty-five years, male, previous abdominal distress, present attack colicky pain, vomiting meteorism, tenderness, rigidity, no tumor in right lower quadrant no mass felt per rectum, temperature 35° C, no melena, duration fourteen hours, abdominal exudate, diverticulum contained a tumor, but was not gangrenous, no operation, death

CASE XIII—Haeberlin,<sup>5</sup> 1908, age three years, female, melena at birth, vague gastroenteritis for one year, present illness colicky pain, vomiting, no meteorism, tenderness, rigidity, tumor in right lower quadrant, no melena, duration, fourteen days of daily cramps, operation diverticulum contained no tumor, was not gangrenous and was reducible, resection of diverticulum only by a wedge-shaped incision, recovery

CASE XIV—Gaudier<sup>47</sup> 1909, age twelve years male, present illness colicky pain with visible peristaltic waves, vomiting, no meteorism, no melena, duration four days, operation abdominal exudate, diverticulum contained no tumor and was not reducible, resection of bowel with end-to-end anastomosis, recovery

CASE XV—Moore,<sup>68</sup> 1911, age twenty-five years, attacks of colic for several years, present illness colicky pain, duration, one day, diverticulum contained no tumor, was not gangrenous and was reducible, operation resection of diverticulum only, recovery

CASE XVI—Osmanski,<sup>106</sup> 1911, age seven years, female, present illness pain vomiting, meteorism, tenderness, no tumor in right lower quadrant, no melena, duration two days, operation abdominal exudate, diverticulum contained a tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE XVII—Osmanski,<sup>106</sup> 1911, age eleven years, male, present illness colicky pain vomiting meteorism, extreme tenderness, no tumor in right lower quadrant no melena duration, three days, operation abdominal exudate, diverticulum reducible, resection of diverticulum only, puncture of a distended loop of bowel with a trocar, recovery

CASE XVIII—Gulecke,<sup>34</sup> 1912, age five years, present illness colicky pain, tenderness tumor in right lower quadrant, no mass felt per rectum bloody diarrhœa, duration fourteen days, operation diverticulum contained a tumor and was reducible resection of diverticulum only, recovery

CASE XIX—Gaardlund<sup>46</sup> 1912, age fourteen years, male, abdominal pain seven years before, present illness colicky pain, vomiting, no meteorism tenderness no rigidity, tumor in right lower quadrant, mass felt per rectum, temperature 37.5° C, melena duration nine hours, operation no abdominal exudate, diverticulum contained a tumor,

was gangrenous and was reducible, resection of diverticulum only, subsequent bowel resection, recovery

CASE XX—Hopfner,<sup>7</sup> 1912, age nine years, male, no previous attacks, present illness pain, vomiting, meteorism, tenderness, rigidity, no tumor in right lower quadrant, no mass felt per rectum, no fever, duration, one day, operation abdominal exudate, diverticulum contained a tumor, was gangrenous, and was not reducible, resection of bowel, recovery

CASE XXI—Marquis,<sup>89</sup> 1913, age three years, present illness pain, tumor in right lower quadrant, melena, duration, thirty-six hours, operation diverticulum contained no tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE XXII—Brennecke,<sup>12</sup> 1913, age five years, male, previous abdominal distress, present illness pain, vomiting, melena, duration, one day, operation diverticulum contained no tumor, was gangrenous and not reducible, resection of bowel, recovery

CASE XXIII—Kaspar,<sup>3</sup> 1914, age thirteen years, male, present illness colicky pain, faecal vomiting, meteorism, tenderness, no tumor in right lower quadrant, temperature 37.6° C, duration, twelve days, operation abdominal exudate, diverticulum contained a tumor, was gangrenous and was reducible, resection of diverticulum only and side-to-side anastomosis of small bowel, death

CASE XXIV—Fromme,<sup>44</sup> 1914, age seven years, male, no previous abdominal distress, present illness pain, vomiting, tenderness, rigidity, tumor in right lower quadrant, temperature 37.5° C, melena, duration, two days, operation diverticulum contained no tumor, was gangrenous and was reducible, resection of bowel, recovery

CASE XXV—Fauntleroy,<sup>40</sup> 1916, age twenty-four years, male, no previous abdominal distress, present illness colicky pain, vomiting, meteorism, no tumor in right lower quadrant, no mass felt per rectum, temperature 36.6° C, no melena, duration, two hours, operation diverticulum contained no tumor, was not gangrenous and was reducible, the bowel was gangrenous, resection of diverticulum and resection of bowel because diverticulum was not on the gangrenous portion of the bowel, recovery

CASE XXVI—Vangsted,<sup>120</sup> 1918, age ten years, female, present illness pain of two days' duration, operation abdominal exudate, resection of bowel, recovery

CASE XXVII—Carlson,<sup>17</sup> 1919, age eighteen years, male, had abdominal pain day before onset, present illness colicky pain, vomiting, no meteorism, tenderness, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, no fever, no melena, duration, two days, operation abdominal exudate, diverticulum contained no tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE XXVIII—Carlson,<sup>17</sup> 1919, age four years, male, often complained of griping pains, abdominal pain two days before onset, present illness colicky pain, vomiting, no meteorism, tenderness, no rigidity, tumor in right lower quadrant, no mass felt per rectum, no melena, duration, seven hours, operation diverticulum contained no tumor, was not gangrenous and was not reducible, resection of bowel, recovery

CASE XXIX—Guibe,<sup>53</sup> 1919, age four years, previous attack five days before with complete recovery, present illness pain, vomiting, meteorism, no tumor in right lower quadrant, no mass felt per rectum, melena, duration, five days, operation no abdominal exudate, diverticulum contained no tumor, was gangrenous and was reducible, spinal anaesthesia, died on operating table

CASE XXX—Boulay,<sup>9</sup> 1920, age eleven years, female, present illness pain, vomiting, no meteorism, tenderness, no tumor in right lower quadrant, no mass felt per rectum temperature 37.5° C, melena, duration, thirty hours, operation abdominal exudate, diverticulum contained no tumor, was not gangrenous and was not reducible, resection of bowel, recovery

CASE XXXI—Fabre,<sup>39</sup> 1920, age twelve years, female, previous abdominal distress, present illness colicky pain, vomiting, no meteorism, tenderness, tumor in right lower

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quadrant, temperature  $38.5^{\circ}\text{C}$ , duration, thirty hours, operation diverticulum contained no tumor, was not gangrenous and was not reducible, resection of bowel, death

CASE XXXII—Coutts,<sup>23</sup> 1920, age four years, male, present illness pain, tenderness, rigidity, tumor in right lower quadrant, melena, operation diverticulum contained a tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE XXXIII—King,<sup>76</sup> 1921, age twenty-six years, male, previous attack two months before, present illness pain, operation ileum perforated with much abdominal exudate, diverticulum not reducible, resection of bowel, recovery

CASE XXXIV—Frohlich,<sup>43</sup> 1921, age four years, male, daily pain for eight days, two days before operation fell on abdomen, six hours later attack began, present illness pain, vomiting, no meteorism, rigidity, tumor in right lower quadrant, no melena, duration, two days, operation diverticulum contained a tumor and was not reducible, resection of bowel, death

CASE XXXV—Depisch,<sup>27</sup> 1921, age twenty-five years, female, abdominal pain two years before, present illness colicky pain, vomiting, no meteorism, no tenderness, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, temperature  $37.6^{\circ}\text{C}$ , no melena, duration, thirty hours, operation abdominal exudation, diverticulum contained a tumor, was gangrenous and was reducible, resection of bowel, recovery

CASE XXXVI—Wienecke,<sup>130</sup> 1921, age two years, male, attack a few weeks before, present illness pain, vomiting, visible peristalsis, no meteorism, no tenderness, no rigidity, temperature  $37.5^{\circ}\text{C}$ , melena, duration, thirty-six hours, operation abdominal exudate, diverticulum contained no tumor, was not gangrenous and was reducible, resection of bowel, recovery

CASE XXXVII—Hood,<sup>60</sup> 1923, age eight years, male, abdominal pain several years before, present illness pain, vomiting, tumor in right lower quadrant, no mass felt per rectum, temperature  $37.2^{\circ}\text{C}$ , melena, duration, eighteen hours, operation diverticulum contained no tumor, was gangrenous and not reducible, resection of bowel, recovery

CASE XXXVIII—Vickers,<sup>130</sup> 1923, age seven years, male, present illness colicky pain, vomiting, meteorism, tumor in left lower quadrant, melena, duration, thirty-six hours, operation diverticulum gangrenous but reducible, resection of bowel, recovery

CASE XXXIX—Fuchsig,<sup>45</sup> 1923, age eighteen months, male, frequent previous attacks of abdominal pain, present illness pain, vomiting, no meteorism, tumor above umbilicus, no melena, duration, twelve hours, diverticulum contained a tumor, was gangrenous and was not reducible, resection of bowel, death

CASE XL—Fuchsig,<sup>45</sup> 1923, age seventeen years, male, no previous attacks, present illness pain, meteorism, tenderness, tumor in right lower quadrant, temperature  $39.0^{\circ}\text{C}$ , no melena, duration, five days, operation diverticulum contained no tumor, was gangrenous and was reducible, resection of bowel, death

CASE XLI—Fuchsig,<sup>45</sup> 1923, age nineteen years, male, frequent abdominal pains as a child, present illness pain, vomiting, meteorism, rigidity, tumor in right lower quadrant, no fever, no melena, duration, six hours, operation diverticulum contained no tumor, was not gangrenous and was not reducible, resection of bowel, recovery. Second bowel resection several months later because of adhesions

CASE XLII—Johnson,<sup>71</sup> 1923, age eight months, male, no previous attacks, present illness colicky pain, vomiting, meteorism tenderness, tumor in right lower quadrant, temperature  $37.7^{\circ}\text{C}$ , no melena, duration, thirty-six hours, operation diverticulum contained no tumor, was gangrenous and was not reducible, resection of bowel, death

CASE XLIII—Greenwood,<sup>70</sup> 1923, age thirty years, female, no previous attacks, present illness colicky pain, vomiting, no meteorism, tenderness, rigidity, tumor in right lower quadrant, mass felt per vaginum, temperature  $36.6^{\circ}\text{C}$ , no melena, duration two days, operation diverticulum contained no tumor, was gangrenous and was reducible, resection of bowel, recovery

CASE XLIV—Stone,<sup>130</sup> 1923, age eighteen months, male, no previous attacks, present illness pain, vomiting, no meteorism, no tenderness, tumor on left side no mass felt

per rectum, melena, duration twelve hours, operation the bowel was not involved in the invagination, only the diverticulum being inverted, diverticulum contained no tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE XLV—Braun and Worthman,<sup>11</sup> 1924, age eighteen months, male, present illness vomiting, tumor on left side, mass prolapsed from rectum, duration, eight hours, operation diverticulum reducible, resection of diverticulum only, death

CASE XLVI—Lower,<sup>86</sup> 1925, age forty-three years, male, attacks of abdominal pain for one year, three attacks in past week, present illness colicky pain, vomiting, meteorism, rigidity, tumor in right upper quadrant, no mass felt per rectum, fever, no melena, duration, two hours, operation diverticulum contained no tumor, was gangrenous and was not reducible, resection of bowel, recovery

CASE XLVII—Lower,<sup>86</sup> 1925, age forty-four years, female, attacks of colic for six months, present illness colicky pain, vomiting, meteorism, tenderness, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, no melena, duration, seven days, operation diverticulum contained no tumor and was not reducible, resection of bowel, outcome not stated

CASE XLVIII—Kaspar,<sup>4</sup> 1925, age fifteen years, male, previous attack three days before with complete recovery, present illness colicky pain, vomiting, meteorism, tenderness, rigidity, no tumor in right lower quadrant, no melena, duration, three days, operation abdominal exudate, diverticulum contained a tumor, was gangrenous and was reducible, resection of bowel, recovery

CASE XLIX—Mathews,<sup>90</sup> 1925, age thirty years, male, present illness colicky pain, vomiting, duration, two days, operation diverticulum was not gangrenous and was reducible, resection of bowel, death

CASE L—Wessel,<sup>135</sup> 1926, age thirty-four years, male, abdominal pain for eighteen months, present illness pain, melena, operation resection of bowel, recovery

CASE LI—Schlutz,<sup>118</sup> 1927, age three months, present illness meteorism, fever, melena, operation diverticulum contained no tumor, was not gangrenous and was reducible, resection of bowel, death

CASE LII—Mathieu and Davioud,<sup>91</sup> 1927, age seven years, male, painful melena three years before and seven months before, present illness colicky pain, vomiting, rigidity, no tumor in right lower quadrant, no mass felt per rectum, temperature 37.5° C, melena, duration, twelve hours, operation abdominal exudate, diverticulum contained a tumor, was not gangrenous and was not reducible, resection of bowel, recovery

CASE LIII—Mathieu and Davioud,<sup>91</sup> 1927, age one year, male, present illness melena of sixty hours' duration, operation diverticulum reducible, simple disinvagination, no resection, death

CASE LIV—Picot,<sup>110</sup> 1927, age thirteen years, male, colic since birth, present illness colicky pain, vomiting, no meteorism, tenderness, no rigidity, tumor in right lower quadrant, no melena, duration, thirty-six hours, operation diverticulum contained a tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE LV—Holst,<sup>65</sup> 1928, age twelve years, male, attacks of abdominal pain for five months, present illness pain, tenderness, rigidity, no tumor in right lower quadrant, temperature 38.0° C, duration, twenty-six hours, operation abdominal exudate, diverticulum contained a tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE LVI—Montgomery,<sup>97</sup> 1928, age two years, female, no previous abdominal distress, present illness pain, vomiting, no meteorism, tenderness, tumor in right lower quadrant, no mass felt per rectum, melena, duration, one day, operation diverticulum contained a tumor, was not gangrenous and was reducible, simple disinvagination, no resection, death

CASE LVII—Eisberg,<sup>34</sup> 1928, age eleven years, male, abdominal pain one year before, present illness colicky pain, vomiting, no meteorism, tenderness, tumor in right lower quadrant, no mass felt per rectum, no melena, duration, thirty-six hours, operation

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abdominal exudate, diverticulum contained a tumor, was gangrenous and was not reducible, intussusception was double, resection of bowel, recovery

CASE LVIII—Pedersen,<sup>107</sup> 1928, age two years, male, umbilical hernia since birth, present illness melena of one day's duration, operation diverticulum gangrenous, no resection, anastomosis only, death

CASE LIX—Pedersen,<sup>107</sup> 1928, age eight years, male, present illness colicky pain of two days' duration, operation abdominal exudate, diverticulum reducible and not gangrenous, resection of diverticulum only, recovery

CASE LX—Pedersen,<sup>107</sup> 1928, age twenty years, male, present illness pain and melena of three days' duration, operation abdominal exudate, diverticulum gangrenous and not reducible, resection of bowel, recovery

CASE LXI—Decker,<sup>25</sup> 1928, age seven years, male, no previous abdominal crises, present illness colicky pain, vomiting, meteorism, tenderness, rigidity, tumor in right lower quadrant, no mass felt per rectum, temperature 37.5° C, melena, duration, three days, operation abdominal exudate, diverticulum reducible and not gangrenous, resection of diverticulum only, death

CASE LXII—Macdonald,<sup>87</sup> 1928, age forty years, male, no previous abdominal distress, present illness colicky pain, vomiting, meteorism, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, no melena, duration, fourteen days, operation diverticulum contained a tumor, was not gangrenous and was not reducible, resection of bowel and colostomy, recovery

CASE LXIII—Pettersen,<sup>109</sup> 1928, age seven years, female, present illness colicky pain, tenderness, no tumor in right lower quadrant, no mass felt per rectum, temperature 38.3° C, duration, two days, operation abdominal exudate, diverticulum contained a tumor, was not gangrenous and was reducible, resection of diverticulum only, recovery

CASE LXIV—Cannon,<sup>10</sup> 1928, age eighteen months, female, operation diverticulum not gangrenous and reducible, resection of diverticulum only, recovery

CASE LXV—Allman,<sup>3</sup> 1928, age eight years, male, no previous abdominal distress, present illness colicky pain, vomiting, meteorism, rigidity, no tumor in right lower quadrant, temperature 37.6° C, no melena, duration, three days, operation abdominal exudate, diverticulum contained no tumor, was gangrenous and was reducible, resection of diverticulum only, recovery

CASE LXVI—McIver,<sup>94</sup> 1928, age twelve years, male, abdominal pain eight months before, present illness colicky pain, vomiting, no meteorism, tenderness, rigidity, no tumor in right lower quadrant, no mass felt per rectum, temperature 40.0° C, no melena, duration, forty hours, operation abdominal exudate, diverticulum contained no tumor, was gangrenous and not reducible, bowel resection and colostomy, death

CASE LXVII—Doolin,<sup>30</sup> 1929, age forty-four years, male, operation five days before for right inguinal hernia at which time a normal Meckel's diverticulum was seen in the hernial sac, onset of present illness with sudden onset of colicky pain, vomiting, tumor in right lower quadrant, and melena, duration, three hours, operation diverticulum contained no tumor, was not gangrenous and was not reducible, resection of diverticulum only from within the bowel, recovery

CASE LXVIII—Livingston,<sup>85</sup> 1929, age eighteen months, male, present illness colicky pain, vomiting, no rigidity, tumor in right lower quadrant, no mass felt per rectum, no melena, duration, six hours, operation diverticulum contained no tumor, was not gangrenous and all but its tip was reducible, resection of diverticulum only, recovery

CASE LXIX—Christopher,<sup>20</sup> 1930, age nine months, male, no previous attacks, present illness colicky pain, vomiting, tumor in right lower quadrant, no mass felt per rectum, melena, duration, ten hours, operation abdominal exudate, diverticulum contained no tumor, was gangrenous and was reducible, disinvagination followed by ileostomy several days later, death



## HENRY N HARKINS

CASE LXX—Lenner,<sup>8</sup> 1930, age six months, male, present illness pain, vomiting, meteorism, tenderness, no rigidity, no tumor in right lower quadrant, no mass felt per rectum, much melena, duration, three days, operation diverticulum contained no tumor, was gangrenous and was reducible, resection of diverticulum only with ileocolic anastomosis, death

CASE LXXI—Trask and Turvey,<sup>125</sup> 1921, age one year, male, no previous attacks, present illness no pain, no colic, vomiting, meteorism, no tenderness, no rigidity, tumor in right lower quadrant, no mass felt per rectum, no fever, no melena, duration, four days, operation diverticulum contained no tumor and was gangrenous, ileostomy, result not stated

CASE LXXII—Andrews,<sup>4</sup> 1932 Vide supra

CASE LXXIII—Harkins, 1932 Vide supra

CASES LXXIV to CXIV—Hertzler and Gibson,<sup>61</sup> 1913, average age thirteen years in forty cases with data given, thirty-one males, seven females in thirty-eight cases with data given, previous attacks, seventeen out of twenty cases with data given, pain, thirty-one out of thirty-one cases with data given, vomiting twenty-seven out of twenty-seven cases with data given, meteorism, seventeen out of twenty-two cases with data given, tenderness, ten out of fifteen cases with data given, rigidity, four out of nine cases with data given, tumors in right lower quadrant, sixteen out of twenty-four cases with data given, mass felt per rectum, two out of five cases with data given, colic, sixteen out of sixteen cases with data given, fever three out of seven cases with data given, melena, twelve out of eighteen cases with data given, duration of attack, average 132 hours in twenty-two cases with data given, abdominal exudate, ten out of eleven cases with data given, tumor of diverticulum, five out of six cases with data given, gangrene, eleven out of twelve cases with data given, diverticulum reducible, eleven out of twenty-five cases with data given, resection of diverticulum only, eleven out of forty-one cases with data given, resection of bowel, twenty-three out of forty-one cases with data given, and recovery, twenty-one out of forty-one cases with data given

### REPORTED CASES GROUP II

Series of forty-six cases with such incomplete data that they cannot be included in the analysis of data The division between Groups I and II is of necessity somewhat arbitrary Reports of intussusception of a Meckel's diverticulum that has prolapsed from the umbilicus such as the case of Peters, or the four cases of Corner,<sup>22</sup> are not included in either Group I or Group II

CASE CXV—Pathological specimen in St Bartholomew's Hospital Anatomical Museum, 1846 Male, aged thirty-six The patient had attacks of abdominal pain for six months before death from intestinal obstruction and peritonitis The specimen is that of a somewhat gangrenous ileocolic intussusception with a diverticulum of the ileum at the apex

CASE CXVI—Treves,<sup>127</sup> 1884, pathological specimen

CASE CXVII—Heller,<sup>60</sup> 1885, male, aged seventy, pathological specimen

CASE CXVIII—Heller,<sup>60</sup> 1885, male, aged sixty-six, death from pyonephrosis, pathological specimen

CASE CXIX—Ingle,<sup>68</sup> 1888, child, aged five months, with vomiting, abdominal pain, tympanites, hiccough, and bloody mucus in the rectum There was no tumor or tenderness evident on palpation No operation Death on the fifth day Pathological specimen

CASE CXX—Adams,<sup>2</sup> 1891, male, with obscure symptoms of intestinal strangulation for two weeks No operation Pathological specimen

CASE CXXI—Willett,<sup>127</sup> 1891, male Pathological specimen

CASE CXXII—Heller,<sup>68</sup> 1891, male, aged forty-six Death from perforated peptic ulcer Necropsy showed an invaginated Meckel's diverticulum with an accessory pancreas at its tip

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CASE CXXIII—O'Connor,<sup>105</sup> 1894, male, aged thirteen, with absolute constipation for eight days and pain for two days, passed per rectum an invaginated portion of intestine eleven inches long with an attached Meckel's diverticulum. The patient was alive and well a year later.

CASE CXXIV—McFarland,<sup>93</sup> 1901, male, aged sixty, death from intestinal obstruction and uræmia. Necropsy showed purulent peritonitis and a Meckel's diverticulum four centimetres long rotated 90° and invaginated for about two centimetres into the ileum, producing gangrene and partial obstruction.

CASE CXXV—Smith,<sup>110</sup> 1903, pathological specimen.

CASE CXXVI—Treves,<sup>127</sup> 1903, pathological specimen.

CASE CXXVII—Porter,<sup>112</sup> 1905, male, aged three, with symptoms of complete intestinal obstruction. Death during laparotomy. The child was moribund before operation. An invaginated ileum and invaginated Meckel's diverticulum were found.

CASE CXXVIII—Hirschsprung,<sup>63</sup> 1905, male, aged seven, with symptoms of ileus followed by the spontaneous passing of a portion of small bowel with an inverted diverticulum at the end. Death five weeks later from a perforation at the site of the cicatrix.

CASE CXXIX—Hirschsprung,<sup>63</sup> 1905, male, aged five months. A resection of the bowel was performed at the site of an ileal intussusception with inverted Meckel's diverticulum of seventeen hours' duration, death.

CASE CXXX—Jepson,<sup>70</sup> 1905, child, aged sixteen months. At operation the intussuscepted ileum and attached Meckel's diverticulum were readily disinvaginated. Owing to the child's grave condition, the diverticulum was not removed. Three years later there had been no recurrence.

CASES CXXXI to CXXXVI—Hess,<sup>62</sup> 1905. In a series of 314 instances of intussusception collected from the literature, six were due to an invaginated Meckel's diverticulum.

CASE CXXXVII—Guyot,<sup>55</sup> 1907, child, aged ten. Operation was performed the fifth day of an evident intestinal obstruction. Disinvagination was impossible and ileostomy was performed. Death occurred the next day. Necropsy revealed a gangrenous ileal intussusception with an invaginated Meckel's diverticulum.

CASE CXXXVIII—Kingsford,<sup>77</sup> 1909, male, aged ten. Intussusception was diagnosed, but operation not permitted. At necropsy, an intussusception was found with a Meckel's diverticulum at its tip that was not inverted.

CASE CXXXIX—Muller,<sup>103</sup> 1909, male, aged thirty-six. After an acute onset of pain in the cæcal region, the patient had constipation, rectal tenesmus, generalized abdominal tenderness, and moderate distention for three weeks. He then passed per rectum a slough of intestine with an invaginated Meckel's diverticulum. Death occurred two weeks later from perforative peritonitis.

CASES CXL to CXLIII—Walton,<sup>133</sup> 1911. In the years 1901 to 1911 inclusive, 864 cases of intestinal obstruction were admitted to the London Hospital. Of these, 239 or 27.6 per cent were due to intussusception, and in turn, of the 239, four were due to an invaginated Meckel's diverticulum.

CASE CXLIV—Neumann,<sup>104</sup> 1912, male, aged thirty. At operation an ileal intussusception was found with a Meckel's diverticulum at its apex which was disinvaginated. No resection, recovery.

CASES CXLV to CLI—Koch and Oerum,<sup>79</sup> 1912. Of 400 cases of intussusception seen in the Copenhagen hospitals, seven were due to an invaginated Meckel's diverticulum.

CASE CLII—Coutts,<sup>27</sup> 1920, male, aged ten months. The patient had severe colicky pain in the abdomen, vomiting, and a tumor palpable to the left of and above the umbilicus when the patient was anesthetized. Operation performed the day after the onset revealed an intussusception that was disinvaginated. At the apex of the intussusception was a cyst two centimetres in diameter which was removed. Death occurred from broncho-

pneumonia The cyst was a few inches oralwards from the ileocaecal valve and was believed to be a remnant of a Meckel's diverticulum

CASES CLIII to CLVII—Perrin and Lindsay,<sup>108</sup> 1921 Of 400 cases of intussusception seen in the London Hospital from 1903 to 1920, five were due to an invaginated Meckel's diverticulum

CASE CLVIII—Braun and Worthman,<sup>11</sup> 1924, male, aged thirty, with a fifteen-centimetre long ileal intussusception and invaginated Meckel's diverticulum Resection of the diverticulum only, recovery

CASES CLIX and CLX—McIver,<sup>64</sup> 1928 In a series of thirteen ileal intussusceptions at the Massachusetts General Hospital, three were caused by an invaginated Meckel's diverticulum (See also Case LXVI)

ANALYSIS OF THE LITERATURE—On the basis of the 114 cases in Group I, an analysis is made of the symptoms, course and treatment of intussusception due to invaginated Meckel's diverticulum In analyzing a large number of cases reported by various authors, it must be remembered that a statistical survey has many limitations Authors are apt to record only positive findings, thus, of forty-three cases where data are given, an abdominal exudate is found thirty-nine times This indicates that an abdominal exudate is present in either 90 per cent or 34 per cent of cases, depending on whether forty-three or the total 114 cases are made the basis of calculation For this reason the use of percentage has been avoided as much as possible Throughout the following analysis, it is to be remembered that 114 cases of intussusception due to invaginated Meckel's diverticulum are under consideration

OCCURRENCE—*Occurrence of Meckel's diverticulum in normal persons*—In 10,360 necropsies, Turner<sup>128</sup> found eighty-one instances of Meckel's diverticulum (0.8 per cent) Forgue and Riche<sup>42</sup> collect statistics of 112 instances of Meckel's diverticulum in 7,850 necropsies (1.4 per cent) Cunningham's<sup>21</sup> *Anatomy* states that it was present in seventy-three of 3,302 bodies (2.2 per cent) Kelynak<sup>70</sup> found it in eighteen of 1,446 bodies (1.2 per cent) Mitchell<sup>66</sup> found thirty-nine in 1,635 necropsies (2.4 per cent) Knox<sup>78</sup> found three in 500 necropsies (0.6 per cent) Schaetz<sup>117</sup> found seventeen in 737 bodies In 2,400 necropsies at the University of Chicago\* from 1902 to 1931, forty-one instances of Meckel's diverticulum were found (1.7 per cent), thirty-one of these were in males and ten in females The ages varied between one day and eighty-six years In no instance was the diverticulum the cause of death

Combining my own series with those of Turner,<sup>128</sup> Forgue and Riche<sup>42</sup> (who include the data of Kelynak<sup>70</sup> and Mitchell<sup>66</sup>), Cunningham,<sup>21</sup> Knox,<sup>78</sup> and Schaetz,<sup>117</sup> there are 327 instances of Meckel's diverticulum in 25,149 necropsies, or 1.3 per cent This agrees with the operative statistics of Harbin,<sup>59</sup> who found seven instances of Meckel's diverticulum in 507 consecutive laparotomies where a routine exploration was performed (1.4 per cent) In Balfour's<sup>5</sup> statistics of fifteen cases of Meckel's diverticulum in 11,107 laparotomies (0.1 per cent), the incidence was lower because a routine exploration was not performed

*The proportion of all cases of intussusception that is caused by a Meckel's diverticulum*—Fitzwilliams<sup>41</sup> finds fifteen cases of the Meckel's diverticulum type of intussusception in a series of 1,000 intussusceptions Eliot and Corscaden,<sup>35</sup> twenty-nine out of 300, Koch and Oerum,<sup>79</sup> seven out of 400

\* I am indebted to Dr Esmond Long for permission to publish these figures

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TABLE I

*Incidence of Meckel's Diverticulum from Necropsy Figures*

Author	No of Necropsies	No of Cases of Meckel's Diverticulum	Percentage Incidence of Meckel's Diverticulum
Turner	10,360	81	0 8
Forgue and Riche	7,850	112	1 4
Cunningham	3,302	73	2 2
Knox	500	3	0 6
Schaetz	737	17	2 3
Harkins	2,400	41	1 7
Total	25,149	327	1 3

Perrin and Lindsay,<sup>108</sup> five out of 400, and Hess,<sup>62</sup> six out of 314. From these collections, it seems that a Meckel's diverticulum is a factor in about 2 5 per cent of intussusceptions. This figure is probably too high because Fitzwilliams<sup>41</sup> and Eliot and Corscaden<sup>35</sup> collected their cases from the literature where rare cases are more likely to be reported and 1 5 per cent probably represents a more accurate figure. This is practically the same as the incidence of Meckel's diverticulum in normal persons. From these statistics it appears that persons with a Meckel's diverticulum may not be more likely to develop intussusception than normal individuals, but if an intussusception does develop, it does so at the site of the Meckel's diverticulum.

*Relationship of intussusceptions due to Meckel's diverticulum and other diseases of Meckel's diverticulum*—Porter<sup>112</sup> found twenty cases of intussusception in a series of 184 affections of Meckel's diverticulum. Forgue and Riche<sup>42</sup> found thirty-four intussusceptions in 287 cases of obstruction due to the organ, Drummond<sup>32</sup> found seven out of twenty-two, and Wellington,<sup>134</sup> fifty nine out of 326. Thus it would seem that 17 per cent of the Meckel's diverticula that cause trouble do so by producing intussusception. Halstead<sup>58</sup> finds that 6 per cent of 991 cases of acute intestinal obstruction were due to a Meckel's diverticulum.

## GEOGRAPHICAL DISTRIBUTION

Various authors, including Fuchsig<sup>45</sup> and Koch and Oerum,<sup>79</sup> have pointed out that intussusception is most commonly reported in England, Denmark, Australia, and the United States, and is rarely seen in Germany and Austria. No figures are available as to the geographical distribution of Meckel's diverticulum. In the series of the Meckel's diverticulum type of intussusception collected in the present paper, the distribution seems to follow somewhat that of intussusception. Of the 160 cases, England reported forty-seven, Germany, forty-one, the United States, twenty-eight, Denmark, eighteen, France, sixteen, Sweden, three, and Russia, Spain, Switzerland, and Australia, each one.

*AGE*—*Age of patients with intussusception of all types*—Hess<sup>62</sup> found

that 64 per cent of his 314 cases of intussusception occurred under the age of one year. Other authors reported the following percentages as occurring under one year: 60 per cent (Koch and Oerum, of these, two-thirds were between five and seven months of age), 70 per cent (Perrin and Lindsay, of these, three-fourths were between five and nine months of age), 72 per cent (Walton<sup>132</sup>), and 72 per cent (Fitzwilliams). Thus it is seen that most ordinary intussusceptions occur below the age of one year, and of these, a large proportion occur in the period between five and nine months of age.

*Age of patients with affections of Meckel's diverticulum of all types*—The average of Porter's series was twenty-one years. Only 28 per cent of Forgue and Riche's patients were afflicted in the first decade of life.

*Age of patients with intussusception due to Meckel's diverticulum*—The average age of the patients in the present series is 13.1 years. The forty cases collected by Hertzler and Gibson<sup>61</sup> averaged 13.0 years. Only six of the cases in the present series were below one year of age. In Table II is given the age distribution by decades, the age limits being three months and forty-nine years.

TABLE II

*Age Distribution by Decades of Patients with Intussusception Due to Inverted Meckel's Diverticulum*

Age in years	0-10	11-20	21-30	31-40	41-50
Number of cases	60	24	15	7	5

It is seen that the age distribution of the Meckel's diverticulum type of intussusception does not agree at all with that of intussusception as a whole. It agrees somewhat with that of other affections of Meckel's diverticulum. In reviewing 300 cases of intussusception in adults, Eliot and Corscaden<sup>35</sup> found the enteric variety more common than in children. McIver found all of his thirteen cases of enteric intussusception were over thirteen years of age. Perrin and Lindsay have graphed separately the age distribution of the various types of intussusception, finding that the ileocaecal and ileocolic types have the usual age-distribution curve, being much more common in infants, while the colic does to a slight extent, and the enteric has little relation to age. Thus it seems that the age distribution of the Meckel's diverticulum type of intussusception is similar to enteric intussusception.

*SEX*—*Sex of patients with intussusception of all types*—Sixty-eight per cent of Fitzwilliam's cases of intussusception, 69 per cent of Koch and Oerum's cases, and 64 per cent of Perrin and Lindsay's cases are males.

*Sex of patients with affections of Meckel's diverticulum of all types*—The percentage of males as given by various authors is as follows: 75 per cent (Porter), 76 per cent (Wellington), and 82 per cent (Forgue and Riche). In the University of Chicago necropsy series, in no cases of which was there any affection of the Meckel's diverticulum, 76 per cent were males.

*Sex of patients with intussusception due to Meckel's diverticulum*—Since the preponderance of intussusceptions and of Meckel's diverticula when

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occurring separately is in males, it is not surprising that the combination attacks males more frequently than females. In 105 cases in the present series where the sex is given, 79 per cent are males.

*Previous abdominal crises*—No data are available as to the proportion of all types of intussusception that have had previous attacks, but in general it is recognized that intussusception is an acute disease with rare recurrences. All writers on intussusception due to Meckel's diverticulum have noted the frequent history of abdominal crises. In the present series, in forty-six cases there was a definite history of previous abdominal crises, in twenty-one cases it was stated that there was no history of previous abdominal distress, and in forty-seven cases no data were given.

*Duration of the final attack*—Closely related to the history of previous abdominal distress is the duration of symptoms of the final attack. In many of the cases reviewed for this paper, the symptoms were of such long duration and of such remittency that it was difficult to tell exactly when the present illness began. Furthermore, since most of the cases were terminated, successfully or otherwise, by operative intervention, the duration of the final attack was as much dependent upon the impression of necessity for operation that the disease aroused in the minds of the surgeons as it was upon the severity of the disease itself. A surgeon often tends to delay where he cannot make a definite diagnosis, even though operative indications are present. Thus there is a psychological element that may affect the duration of the attack that is terminated by operation. In both the patients operated upon at the University of Chicago, and in a considerable number of the cases reviewed, there was a less severe attack a day or two before the final severe attack. Some authors believe this is due to the inversion of the diverticulum before the bowel becomes invaginated. Perrin and Lindsay found the average duration of 156 ileocaecal intussusceptions was thirty-eight hours, of 126 ileocolic intussusceptions was thirty-three hours, and of twenty-seven enteric intussusceptions was eighty-four hours. The cases due to Meckel's diverticulum agree much more closely with this last figure. Corner points out that "as the origin of the invagination is lateral, the ring where the bowel is infolded is very oblique, and consequently the intestinal lumen is not completely occluded, and the case may be clinically subacute. This is a very interesting pathological fact, and explains why some of the recorded cases give long subacute histories." In the 114 cases, of eighty-eight cases where the duration of the final attack was given, the average was 81.6 hours. Some of the earlier cases were allowed to go longer before operation because Hertzle and Gibson's portion of the series, all reported before 1912, averaged 132 hours. The remainder averaged 64.3 hours, reducing the grand average as stated before to 81.6 hours.

*Pain*—Pain was present in 76 per cent of the cases under one year and 85 per cent of those over one year in Koch and Oerum's series of intussusception of all types. In the present series of intussusception due to Meckel's diverticulum, pain was present in ninety-seven cases, definitely stated to be

absent in one case, and no data were given in sixteen cases. The pain was quite often of a colicky type. In the present series, it was stated to be colicky fifty-two times, stated not to be colicky twice, and in sixty instances no data were given on this point. One of the University of Chicago patients (Case LXXIII) had a very definite colic, occurring every seven to eight minutes with almost complete relief between attacks. The fact that the patients are older in the type of intussusception due to Meckel's diverticulum than in ordinary intussusception may explain the more frequent recording of pain. When intussusception of the large bowel occurs, the mesentery is not necessarily dragged along with the intussusception, but in enteric intussusceptions, whether or not due to a Meckel's diverticulum, the mesentery is usually dragged into the infolding and the traction may be one of the chief elements in the more frequent pain in this type of intussusception.

*Vomiting*—In Koch and Oerum's series of intussusception of all types, vomiting was present in 92 per cent of the cases under one year and 91 per cent over one year. In Hess' series of 314 cases, vomiting was present in 166 and absent in four. Since the obstruction in the Meckel's diverticulum variety of intussusception is higher in the intestinal tract, one might expect vomiting to be more frequent than in ordinary intussusception. In the present series, vomiting was present eighty-two times, in no case was it definitely stated to be absent, and data were not given on this point thirty-two times. In the two University of Chicago patients, vomiting was out of all proportion to the other symptoms.

*Meteorism*—Since the obstruction due to the Meckel's diverticulum type is higher than in ordinary intussusception, more vomiting and less meteorism would be expected. This might be equalized to some extent in that the Meckel's diverticulum variety of intussusception is less readily diagnosed and allowed to run a longer course before operation. In the present series, meteorism was stated to be present forty-five times, absent twenty-four times, and forty-five times no statement concerning it was made.

*Tenderness and rigidity*—These signs are present in about an equal proportion of all intussusceptions. In the present series, tenderness was present forty-one times, absent thirteen times, and no data were given sixty times. Rigidity was present twenty times, absent twenty-two times, and no data were given seventy-two times. In several cases there was no tenderness or rigidity in spite of well-advanced gangrene. Tenderness, rigidity, and abdominal exudate may be indicative of the extent of injury to the intestinal outer coats, including the peritoneum, while blood in the stools gives similar evidence of the state of nutrition of the mucous membranes.

*Abdominal tumor*—Statistics show that in ordinary intussusception a tumor is palpable abdominally in the following proportion of cases: 63 per cent (Perrin and Lindsay), 83 per cent (Eccles<sup>33</sup>), 93 per cent (Hess), and 85 per cent (Koch and Oerum). The last-named authors find a tumor equally frequent in patients below and above one year of age. They also state

that the mass is usually found in the left upper abdominal quadrant due to wandering of the intussusception. Hess states that in ninety-four patients where the position of the tumor was noted, it was on the left side in forty-three instances as opposed to twenty-three on the right. The type of intussusception due to Meckel's diverticulum starts near the cæcum and the tip of the intussusception seldom proceeds beyond the hepatic flexure. Gogibus<sup>48</sup> states that in only 11 per cent of this type of intussusception does the apex reach as far as the transverse colon. Thus, a mass if felt at all would be expected to be on the right side. In the present series, a mass was palpable in the right lower abdominal quadrant forty-one times, in the mid-line or the right upper abdominal quadrant three times, and only five times on the left side. Thirty-three case histories contained no statement on this point.

*Tumor palpable per rectum*—Since the Meckel's diverticulum type of intussusception seldom advances beyond the hepatic flexure, it would be unlikely that a tumor would be palpable per rectum. In only thirty-seven of the 114 cases was it stated that a rectal examination was made. In only four of these was a tumor felt per rectum and two of these were definitely stated to be outside the bowel. On the contrary, in ordinary intussusception, a mass is palpable per rectum rather frequently—48 per cent (Hess), 40 per cent under one year of age and 27 per cent over one year of age (Koch and Oerum), and 27 per cent in ileocæcal intussusceptions and 13 per cent in ileocolic intussusceptions (Perrin and Lindsay).

*Melena*—It is probable that all intussusceptions produce some melena, but in general the type of intussusception caused by Meckel's diverticulum does not produce as much as the ordinary variety. Statistics as to the occurrence of melena in ordinary intussusception are as follows: 89 per cent (Perrin and Lindsay), 89 per cent (Eccles), 97 per cent of cases in which symptom was recorded (Hess), 95 per cent under one year of age and 75 per cent over one year (Koch and Oerum), and 94 per cent in children under two years of age, 62 per cent in larger children, and only 38 per cent in adults (Braun and Worthman). In the present series, forty-three patients had melena, thirty-four did not, and in thirty-seven no data were given. Fuchsig says that the diverticulum may swell and plug the intestine and prevent marked melena.

Another source of melena that must be borne in mind is from ulcers adjoining gastric mucosa in a Meckel's diverticulum. Schaetz found gastric mucosa in five out of thirty Meckel's diverticula found at necropsy (16.6 per cent). All of these patients were males and died of some other disorder, the Meckel's diverticulum being an incidental finding. Lindau and Wulff<sup>84</sup> report thirty-seven instances of gastric mucosa in Meckel's diverticulum with microscopical verification. Seventy-seven per cent of these patients were males. These represent findings at operation, ulceration being present in all cases, perforation in about half and a history of severe hæmorrhage or anæmia being present in most of them. Unlike intussusception with invaginated Meckel's diverticulum, the hæmorrhage in these cases is not accom-



panied by signs of intussusception, the bleeding is apt to be more profuse, the blood may produce a tarry stool, mucus is usually not present, and occasionally there may be a burning pain similar to that produced by ulcer elsewhere. Stone's patient (Case XLIV in my series) had gastric mucosa in an invaginated Meckel's diverticulum. There was no ulceration of the mucosa and the symptoms did not differ radically from other cases in my series.

*Fever*—Hess states that fever occurs in 40 per cent of all cases of invagination in which the symptom is referred to, usually early in the attack. However, Braun and Worthman state that of thirty-three patients with ordinary intussusception, only three had fever above  $38.0^{\circ}\text{C}$  and only seven, any fever at all. In the present series of the Meckel's diverticulum variety of intussusception, fever seems to be insignificant. Thirty-nine patients had their temperature recorded in the case histories. Of these only fifteen had a fever over  $37.5^{\circ}\text{C}$ , and only six of these were over  $38.0^{\circ}\text{C}$ . One patient was moribund with a temperature of  $35.0^{\circ}\text{C}$ . The white blood count was given on only eight cases, being 11,000 (Andrews), 16,000 (Harkins), 14,000 (Johnson), 7,400 (Trask and Turvey), 16,000 (Decker), 27,000 (McIver), 22,000 (Fauntleroy), and 5,000 (Allman).

*Abdominal exudate*—An interesting finding in thirty-nine of forty-three cases where data are given is that of considerable fluid in the peritoneal cavity. In several cases this has been large enough in amount so that it might have been determined by percussion before operation.

*Tumor of the diverticulum*—An interesting feature of twenty-six of the 114 cases is that a tumor was present at the tip of the Meckel's diverticulum. In 1925, Kaspar found thirty-one instances of tumor of Meckel's diverticulum. Fourteen, or almost half, of these had produced intussusception. This group formed about 20 per cent of Kaspar's series of seventy-two cases of intussusception due to Meckel's diverticulum. Since 1925, I find records of seven additional instances of tumor of Meckel's diverticulum, including a papilloma (Picot) and an accessory pancreas (Mathieu and Davioud). Recently Michael and Bell<sup>95</sup> collected eleven cases of malignant tumor of Meckel's diverticulum and reported the first instance of adeno-carcinoma of the organ. Thus, about forty-nine tumors of Meckel's diverticulum are on record, almost a third of which contain pancreatic tissue, and over half of which have produced intussusception. Bize postulates that in these cases the diverticulum may not be of the Meckel's type, but due to traction by the tumor, similar to the traction diverticula in the esophagus. In the University of Chicago necropsy series of forty-one Meckel's diverticula, there is no recorded instance of tumor of the organ.

MISCELLANEOUS FACTORS—*Invagination of the diverticulum only*—Several of the patients, including those of Cheyne, Mothersole, McFarland, Ewald, Maioni, Kuttner and two cases of Heller, had invagination of the diverticulum only. Cheyne's patient had only the mucous membrane of the diverticulum invaginated. Hohlbeck's<sup>64</sup> patient had a complete intussusception.

of the bowel but of the diverticulum, only the mucous membrane was invaginated. In general the symptoms and signs of these cases are similar to those where the entire bowel is intussuscepted. All cases may begin with a primary invagination of the diverticulum. In one patient, the diverticulum was not invaginated even though it formed the apex of the intussusception.

*Umbilical cicatrix*—Three of Drummond's seven patients had abnormal or cicatricized umbilicuses. Gray's patient had an umbilical cicatrix, while Bidwell's<sup>7</sup> patient and Pedersen's first patient had umbilical herniæ. Other authors do not point out such a high frequency of umbilical lesions.

*Spontaneous passage of separated intussusceptum per rectum*—The patients of O'Connor, Hirschsprung (second case), and Muller passed an intussusceptum with an attached Meckel's diverticulum. Two of these patients died later from perforation at the site of the cicatrix in the bowel. The phenomenon of spontaneous passage of intussusceptum is not rare in ordinary intussusception. One of Walton's 239 ordinary intussusceptions passed the tumor spontaneously. Of Eliot and Corscaden's collection of 300 cases of intussusception in adults, forty-three passed a necrotic intussusceptum per rectum, two of these having attached Meckel's diverticula.

*Pathogenesis*—The pathogenesis of intussusception as a whole has been extensively discussed by many authors, especially by Hess. The type of intussusception associated with Meckel's diverticulum and with other tumors seems to have a definite causative factor. Almost always the diverticulum is situated at the apex of the intussusceptum. The chief subject of argument has been whether the diverticulum invaginates primarily or secondarily. Gray believes that the invagination of the diverticulum begins at its base and not at the apex. Except for the one instance where the diverticulum that formed the apex of the intussusceptum was not itself inverted, the bulk of evidence favors the view that the invagination of the diverticulum is primary.

*THERAPY—Type of therapy*—Manifestly, no statistics can ever be advanced to test the medical treatment of intussusception due to Meckel's diverticulum, since the condition can be diagnosed definitely only at laparotomy or necropsy. Judging from ordinary intussusception, surgery is indicated. The only question that remains is the type of operation that is advisable. In general, four types of procedure may be followed: (1) Simple disinvagination, (2) additional resection of the diverticulum, (3) bowel resection, and (4) miscellaneous procedures such as colostomy. Mikulicz colostomy, obliteration of the lumen of the diverticulum, etc. In Table III are presented the results of these various methods. From the table it seems apparent that simple disinvagination, or resection of the diverticulum only are the procedures of choice.

*When the bowel is not gangrenous and the tumor is reducible*—In twenty-three instances there was no gangrene and the intussusception was reducible. Four of these were submitted to bowel resection with 25 per cent recovery. Seventeen were submitted to simple amputation of the diverticulum with 88 per cent recovery. Two cases were only disinvaginated with one

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TABLE III

*Results of the Various Types of Surgical Therapy in Intussusception Due to Inaginated Meckel's Diverticulum*

Type of Operation	No Gangrene Present			Gangrene Present			Total	
	Cases	Recover- ed	Per Cent Recov- ered	Cases	Recover- ed	Per Cent Recov- ered	Cases	Per Cent Recov- ered
Simple disinvagination	7	5	71	0	0	0	7	71
Resection of diverticulum	31	24	77	3	2*	67	34	76
Resection of bowel	29	19	65	30	14	47	59	56
Miscellaneous procedures	4	2	50	4	0	0	8	25
Total	71	50	70	37	16	43	108	61

\* Gangrene of diverticulum only

death and one recovery. Here again the advantage of conservative measures is manifest. Often a portion of bowel is considered gangrenous merely because it is cyanotic and an unnecessary resection is performed. The surgeon may occasionally err in the other direction and not resect a truly gangrenous portion of the bowel, Case LXIX is an example of this. Perrin and Lindsay collect ten instances of gangrene revealed at necropsy where simple disinvagination was done in ordinary intussusception. It is stated that the mucosa may often be gangrenous when the serosa appears viable.

*Removal of the diverticulum*—Bidwell's experience is in favor of removing the diverticulum. This author did not resect the diverticulum and had to do so later because of a recurrence. Although this was the only recurrence in our entire series, of all the cases that survived operation, only five did not have the diverticulum removed. Two of the five had the lumen of the diverticulum obliterated by stitches. Another factor in favor of removal of the diverticulum is that the patients so frequently present a history of previous attacks. It has been said that a Meckel's diverticulum is more of a menace to its possessor than is a vermiform appendix. McDonald<sup>92</sup> finds that of 145 diverticula not presenting lesions only nine were attached, while of 162 causing trouble, 110 were attached. Thus it is the attached diverticula that are such a menace, and not those that hang free, as do those that cause intussusception.

*Bowel resection*—In ordinary intussusceptions, surgeons have learned that resection is very dangerous. This fear is not entirely applicable to intussusception due to Meckel's diverticulum. The difference in the average age of the patients is the deciding factor. Perrin and Lindsay did not have a recovery after resection in any patient under three years of age and could find only eight reports of successful resection of the bowel under one year of age. Dowd<sup>31</sup> finds reports of only six cases with successful bowel resec-

tion in patients younger than one year In the present series, Greenwood's patient was the only infant under three years of age who successfully withstood a bowel resection This patient was eight months old

*Prognosis*—In the present series, 59 per cent of 112 cases recovered Hess states that in ordinary intussusception, of 314 cases, 211 recovered, and only 103 died Seventy-four of these cases had a laparotomy and simple disinvagination with only five deaths There were thirty-eight resections with seventeen recoveries Koch and Oerum state that the operative treatment of ordinary intussusception gave 74 per cent mortality below one year of age and 38 per cent over one year Thus it seems that the prognosis is worse in intussusception due to invaginated Meckel's diverticulum than it is in ordinary intussusception In the present series, of thirty-two patients under five years of age, the death rate was 56 per cent, while of seventy-nine patients, five years of age or over, the death rate was 35 per cent Thus the fact that the patients in the present series are older than those with ordinary intussusception would tend to improve the prognosis, rather than to make it less hopeful

The one explanation for the high mortality in patients with intussusception due to invaginated Meckel's diverticulum is that the condition is not diagnosed soon enough and operation is done only as a last resort This is something that can be changed and the main purpose of this paper is that it may enable earlier diagnoses to be made Hess points out very strikingly that early operation is best in all types of intussusception Table IV gives the mortality rate of patients operated upon at various periods after the onset It is evident that the time factor is a very important element in the prognosis, the mortality being almost three times as high when operation is performed after seventy-two hours as when it is performed before twelve hours have elapsed

TABLE IV

*The Benefit of Early Operation in Intussusception Due to Invaginated Meckel's Diverticulum*

Number of hours before operation	Under 12	12-24	24-48	48-72	Over 72
Number of cases	9	12	26	15	24
Mortality percentage	22	42	31	47	58

**DIFFERENTIAL DIAGNOSIS**—Intussusception due to Meckel's diverticulum must be differentiated from all varieties of acute abdominal emergency It has been most frequently confused with appendicitis because of the age of the patients, the especial involvement of the right lower abdominal quadrant, and the pain and vomiting Unlike appendicitis, the pain is apt to be colicky, there is more frequently blood in the stool, and other signs of intussusception may be present The classical rigidity and tenderness of appendicitis are not so apt to be present The differentiation from other affections of Meckel's diverticulum is apt to be difficult because in both cases there are usually signs of intestinal obstruction However, other affections of Meckel's diverticulum do not have the characteristics of an intussusception

*From intussusception*—Just as intussusception due to Meckel's diverticulum may be differentiated from appendicitis and from other affections of Meckel's diverticulum by the presence of signs of intussusception, so it may be distinguished from ordinary intussusception by the fact that these signs are atypical. Intussusception due to Meckel's diverticulum occurs in older individuals, pain and vomiting are more common, and definite melena and a palpable mass per rectum are much rarer. A mass is palpable in the right lower abdominal quadrant if at all, while in ordinary intussusception, a mass is more commonly felt on the left side. A history of previous attacks is very common and the disease has a much more chronic course, operation being performed only as a last resort, or under some other diagnosis. The choice of operation is simple disinvagination with resection of the diverticulum, but when necessary, bowel resection is less dangerous than in ordinary intussusception because the patients are older.

*From intussusception in adults*—In adults intussusception is most apt to be of the enteric type, which in turn commonly originates from tumors. Kasemeyer collects 284 instances of bowel invagination from tumors, including eighty-five malignant, 192 benign, and seven with the type not stated. Of the benign tumors forty-two were Meckel's diverticula. The age and sex distribution and symptomatology of these cases as a whole are similar to the portion due to Meckel's diverticulum. Most of them affect the small bowel of persons over ten years of age and about 62 per cent are males. McIver states that of thirteen patients with enteric intussusception from all causes at the Massachusetts General Hospital, nine had had previous attacks. Thus in adults, it is difficult to say definitely that an intussusception is due to a Meckel's diverticulum and not to some other cause. But since the treatment and its indications are the same, the differential diagnosis is of but academic interest. Occasionally the presence of a cicatrized umbilicus may indicate the probability of a Meckel's diverticulum as the causative factor.

#### SUMMARY AND CONCLUSIONS

(1) Reports of 160 patients with intussusception due to invaginated Meckel's diverticulum are found in the literature. One hundred fourteen of these are subjected to a statistical analysis.

(2) A clinical differentiation is made between this special type of intussusception and ordinary intussusception. Several distinguishing features of the variety of intussusception due to Meckel's diverticulum are

- (a) It occurs in older individuals
- (b) A history of previous attacks is more frequent
- (c) The course of the disease is more chronic and there is often a mild attack a day or two before the onset of the major illness
- (d) Vomiting is more intense
- (e) If a mass is palpable at all, it is much more apt to be on the right side
- (f) A mass is palpable per rectum in a much smaller proportion of cases
- (g) Bleeding from the rectum is less profuse

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# SYNOVECTOMY OF THE KNEE-JOINT IN CHRONIC ARTHRITIS

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ALTHOUGH synovectomy has been used as an operative procedure with intermittent frequency for the past half century, it is only in the recent few years that its significance in relation to arthritis has been definitely recognized <sup>1</sup>

Volkman,<sup>1</sup> in 1877, was the first to describe the removal of the synovial membrane of a joint in a tuberculous patient. Mignon,<sup>2</sup> in 1899, reported the removal of the synovial membrane from the knee of a patient with chronic arthritis with complete restoration of function in the joint. Goldthwait,<sup>3</sup> in 1900, performed a partial synovectomy in a knee-joint. Hoffa,<sup>4</sup> in 1904, advocated the removal of the synovial membrane of the knee-joint and called attention to the influence of the fat pad adipose tissue on the pathology of the knee. He stated that the normal adipose tissue is liable to grow and to produce an inflammatory hyperplasia even after a slight injury to the joint. Abbott,<sup>5</sup> in 1908, described an operation for the removal of the fringes of the synovial membrane of the knee. His operation was a hit-or-miss method of picking up the synovial membrane, through two lateral incisions, clamping it, and cutting it off. The object was to "catch as much of the capsule as possible." Murphy,<sup>6</sup> in 1916, did two capsulectomies on cases of hypertrophic villus synovitis. The cartilages were removed together with the synovial membrane and a flap of fascia was interposed beneath the patella to avoid adhesions.

The first real correlation of synovial changes with chronic articular disturbances, and the surgical removal of the synovial membrane, was accomplished by Swett<sup>7</sup> and Jones,<sup>8</sup> in 1923. As a result of this work our attitude towards synovectomy has changed so that those who were not in sympathy with this surgical procedure are now openly accepting it as a sane treatment for chronic recurring monarticular polyarticular arthritis. Among the more recent contributors to this subject are Steindler,<sup>9</sup> Allison,<sup>10</sup> Leriche,<sup>11</sup> Key,<sup>12</sup> Sigridson,<sup>13</sup> Speed,<sup>14</sup> and others.

*Anatomical Considerations*—The synovial membrane of the knee-joint is the largest in the body, and lines the capsule of the joint. Three arbitrary spaces are recognized (Fig 1), the suprapatellar space found in front of the femur and beneath the extensor quadriceps tendon above the condyles forms a large pouch, which on distension with gas assumes the form of a gall-bladder (Fig 6). The infrapatellar space is an extension of the synovial membrane into the centre of the joint, between the articular surface of the femur and tibia, and meets the semilunar cartilages, where it is reflected into their upper surfaces around their free inner margins, and back to the portion called the coronary ligament, which it lines down to its tibial attachment. The outline of this space, when filled with gas, is rectangular. The synovial membrane is reflected onto the crucial ligaments, which it invests except behind and below, and thus shuts them out of the synovial cavity. The infrapatellar space is divided by the pad of fat, a loose areolar connective-tissue structure, more or less triangular in shape. The base is directed downward and forward, and its apex is directed to the centre of the joint. This pad is composed of fatty and loose fibrous tissue and is invested by synovial membrane. From its borders extend small villus tags, covered by irregularly placed fibroblastic cells. The pad is held in position by well-defined ligaments, known as the alar ligaments. These ligaments are extensions, or reflections of the synovial membrane, and are found on the lateral peripheral margins of the fat pad, and extend upwards, adapting themselves to the outer and under surface of the patella, blending with the capsule on the under surface of the quadriceps extensor tendon. From the apex of the pad of fat a fold extends to the anterior surface of the

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crucial ligament and is called the ligamentum mucosum. The pad and its villi are very vascular. Their function is that of wiping the joint surfaces with each movement of the knee. In inflammations, and infections of the joint, the pad becomes hyperplastic, and the villi are elongated, and thickened, often filling the infrapatellar space.

The synovial membrane, which plays the most important part in inflammatory processes of joints, does not cover the articular cartilages of the bones which enter into

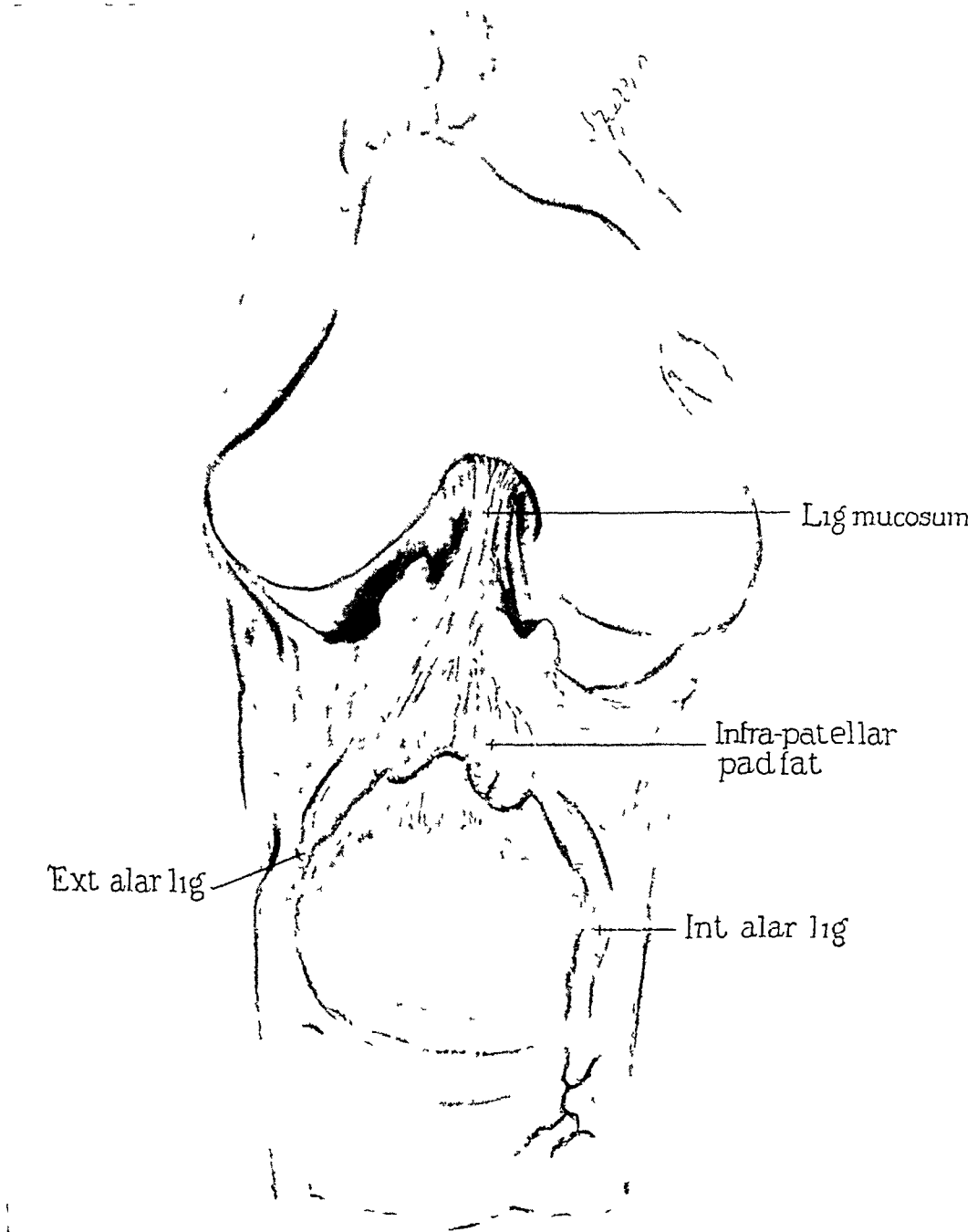


FIG. 1.—Shows the infrapatellar pad fat, and its villus tags. The articular cartilage of the femur is not covered by synovial membrane. Note its distribution and attachments above the condyles.

the formation of the joint, but extends to the edges of the articular cartilage. The capsule of the joint consists of two layers, the stratum synoviale, and the stratum fibrosum. The lining of the joint capsule constitutes the stratum synoviale. The surface of the stratum synoviale is covered by a layer of mesenchymal cells forming no definite lining membrane. It is believed by many histologists that the surface cells resemble true mesothelium, or endothelium, but these cells are now considered to be a modified fibro-

blastic cell, arranged loosely and irregularly to form a continuous smooth surface layer. There is, however, no true epithelium, endothelium, or mesothelium covering the synovial membrane surfaces, that is, the cell limits are not demonstrated by silver nitrate. Hence, the term synovial mesothelium, epithelium, or endothelium, should perhaps be interpreted as meaning areas in which the cells of the synovial membrane surface are closely packed and thus resemble endothelium, or mesothelium. Hueter,<sup>15</sup> in 1866, employing the silver impregnation of Von Recklinghausen,<sup>16</sup> caused considerable controversy when he denied the existence of epithelium lining synovial serous surfaces. This view was later confirmed by two independent workers, Hammar<sup>17</sup> and Braun,<sup>18</sup> who, in 1894, published their result, coming to practically the same conclusion as Hueter.

Arey<sup>19</sup> states that the joint lining in the embryo appears as an undifferentiated mesenchymal homogeneous substance. A cleft appears between the two bone surfaces, and cells from the mesenchymal substance flatten out and line the cleft. The cell limits determine the joint cavity and its synovial surface. The cells in a joint are not so far advanced in their development as are the cells in other cavities, which line serous surfaces. They, therefore, are not as definitely differentiated as are those of other cavities such as pleura, or peritoneum. The cells, however, resemble endothelium in their structure and in their function. Jordan<sup>20</sup> states that the surface of synovial membranes is covered by a single layer of mesenchymal epithelium. Lewis and Stohr<sup>21</sup> also speak of these cells as being mesenchymal epithelium. Key states that the character of the cells found in fluid of normal joints is further evidence that joint cavities are clefts in the connective tissue, which are incompletely lined by slightly modified connective tissue.

The cellular elements do not form a complete mosaic covering over the surface of the synovial membrane. Dense connective tissue fills in the spaces so as to form a uniform and smooth gliding surface. The connective-tissue stratum varies in density in different locations of the joint. In places where the synovial membrane participates in an active gliding mechanism the loose fibrous tissue is quite abundant, but where motion is not so active the fibrous tissue is more dense.

While it may appear that undue space is devoted to a description of the cellular structure of the synovial membrane, in a paper such as this, dealing with a clinical problem, this phase is of interest from the standpoint of tissue regeneration after synovectomy. The question which is most frequently asked is, "What occurs to the joint lining after it has been surgically removed?" It has been found clinically by Allison, and shown experimentally by Key and Wolcott<sup>22</sup> that the synovial membrane reforms within a period of ninety days after its complete removal. If the synovial membrane is of epithelial or endothelial nature, it would follow that epithelization of such a large denuded surface would be rather difficult, unless enough tissue were left. This is not the case in the operation of synovectomy, for a considerable extirpation is done, leaving a large, raw surface. However, if the surface cells are fibroblastic, regeneration is more likely to occur. The synovial membrane reforms within a period of about ninety days, and can be "distinguished with difficulty from the normal."

It would appear that the question is still unsettled as to the nature, structure, and manner of regeneration of synovial tissue. Whether the synovial membrane regenerates or is replaced by fibrous tissue, which as a result of use becomes specialized and assumes all the characteristics of synovial membrane, even to the degree of secreting synovial fluid, is a question for

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physiologists and histologists to determine. Suffice it to say that the histological controversies do not influence the clinical side of the question.

*Secretory and Absorptive Power of Synovial Membrane*—The older anatomists and physiologists maintained that the synovial membrane secreted a mucigenous material like the white of an egg for the purpose of lubrication of joints. They further stated that this material was secreted by the endothelial cells of the synovial membrane. Controversy exists regarding the origin of synovial fluid, thus Fisher<sup>27</sup> believes that mucin enters the joint from the surface cells from the deeper cells which empty the synovia through the villi and also from the detached surface cells which have undergone a mucigenous degeneration. Allison<sup>28</sup> and his co-worker found an analogy between synovia and plasma. They found a variation in the protein chloride and sugar content in arthritic synovia. Key<sup>29</sup> states that the cells of the macrophage series are the most important cellular constituents of normal synovial fluid. The origin of synovial fluid becomes still more confusing when the conception of the secretory function of the surface cells is debated. It was very simple to explain the origin of synovia when the surface cells were believed to be endothelial in nature, and the synovia the product of endothelial-cell secretion, namely mucin. But when the surface cells are classed as fibroblastic in character the origin of synovia must be looked upon as coming from a different source. Effusion into the knee-joint as a result of irritation from trauma or infection is quite marked. When the knee-joint is injected with a 1 per cent aqueous iodine solution it becomes promptly distended by a serous exudate. I have also injected dialyzable and soluble materials into the veins of dogs but they were not readily recoverable from the joint synovial fluid. We injected iodides or methylene blue into the veins of dogs, and the material was readily recoverable from the saliva and the urine but it was not found in the joints by the usual tests. Injection into the joint synovial surface is promptly absorbed and is found within a short time in the neighboring lymph-nodes.

Noetzel<sup>30</sup> injected *Bacillus pyocyaneus* into the knee-joints of rabbits and found that from five to ten minutes later the organisms were present both in the inguinal lumbar and crural lymph-nodes and in the circulating blood. Pavlovsky<sup>31</sup> has demonstrated the presence of staphylococci in the blood and in organs of animals from twenty-four to forty-eight hours after inoculation of the knee-joint. He has shown that this dissemination is inhibited or wholly prevented, if before inoculation, an acute inflammation of the joint has been produced by the injection of some sterile irritant. Opie<sup>32</sup> states that the lymph-nodes during the first hour after inoculation are not efficient filters for bacteria. While the quiescent lymph-node is an inefficient filter, the inflamed node containing even at an early period of infection many bacteria is effective in restraining the dissemination of bacteria into the general circulation. He further states<sup>33</sup> that a great variety of substances which are either non-dialyzable, or insoluble in water are dissolved and removed when introduced into the tissues of an animal. India ink, Berlin blue and trypan blue were injected into the knee-joints of dogs by Key,<sup>29</sup> Sigridson,<sup>34</sup> and Rynearson<sup>35</sup> to demonstrate absorption and dissemination by way of the regional lymph-nodes. The process of removal from the synovial membrane is by means of the macrophages.

It can readily be seen that the products of decomposition necrosis or infection of the synovial membrane of the knee-joint, can be taken up by phagocytic action carried to the regional lymph-nodes, and into the general circulation. The absorption from the joint varies with the type of material it contains, and the state of the synovial membrane. In acute septic arthritis the absorption and dissemination are rapid, in chronic arthritis the absorption depends upon areas of healthy tissue.

*Pathology*—The synovial membrane plays the most important part in inflammatory processes of joints. Upon entering an arthritic joint one finds an increase of synovial fluid. In chronic arthritis the amount of fluid varies

with the pathological process and depends upon exacerbation or recession of the inflammation. It is usually considerable, and grayish-yellow in color, and often serosanguineous. It contains particles of detached granulation tissue, and plaques of gray mucus. These mucigenous plaques are found in the joint, floating in the synovial fluid, and frequently adhering to the synovial membrane, filling the recesses of the joint. Ashcroft, Cunningham, McMurry and Pemberton,<sup>31</sup> in a study of fifty cases of arthritis, found one positive culture in the synovial fluid, all of the others being obtained from the synovial membrane and articular cartilage and bone.

The synovial lining of the joint is very much increased in thickness. The fat pad is hyperplastic, thick, elongated, and succulent. The villi are increased in number and size, often filling the joint space. The articular

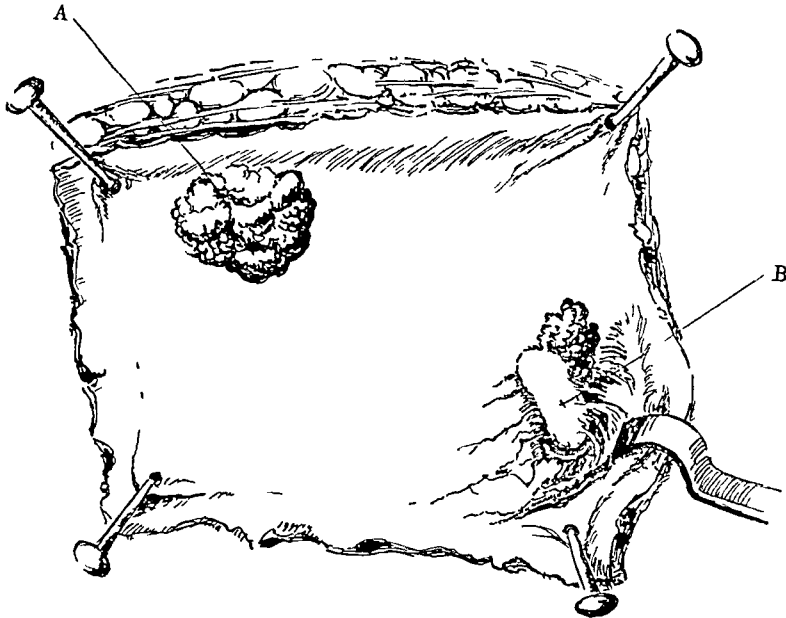


FIG 2—Portion of synovial membrane showing (A) cauliflower like calcified area with granulation tissue surrounding it (B) Large wart like calcified process, with pannus on its upper border. Marked granulation tissue and fibrous bands holding it firmly to the synovial membrane.

cartilage appears pearly gray, smooth, with no erosions. Erosion and destruction of the cartilage occur in the adhesive form of arthritis of the poly-articular type. *In this form, synovectomy should not be performed.* In certain forms of arthritis the articular cartilage shows spicules of proliferated bone at the margins of the synovial attachment, but the gliding surface, the surfaces of contact and pressure, are rarely eroded. Bands of fibrous tissue may be present, these extend from the synovial surface, and stretch across the joint spaces. These bands are more prevalent in the suprapatellar space. Pannus formation is a common finding, and is more frequently seen over the femoral condyles. Calcified material may be found in pouches created by the hyperplasia of the synovial membrane, or attached to the tips of villus processes (Fig 2). True cartilage is rarely found. Cartilaginous bodies are a clinical entity of an entirely different nature, and are associated with osteochondritis dissecans. However, in only three cases have I found carti-

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laminous bodies, and these were associated with disturbances of the semilunar cartilages

*Microscopically*—The most striking picture is that of new vascularization round-cell infiltration and cell proliferation (Fig 3) The lymphocytic infiltration is of the subsynovial fibrous tissue The peripheral cells proliferate so that several layers are deposited on the surface Portions of the synovial membrane show a fibrous stroma with numerous new-formed vessels, around which are many lymphocytes The cells appear in nests or clumps Areas of normal synovial tissue are seen which suddenly disappear and the surface is covered by various sized excrescences of compact fibrous tissue, which in places shows a tendency towards hyalinization and fatty degeneration True cartilages are rarely seen, but areas of calcification may be noted (Figs 4) The areas in which polymorphonuclear leucocytic infiltration and fresh blood-cells are scattered in the tissue are indicative of an exacerbation of the infectious or irritative process Plasma-cells of the polyblastic variety and wandering macrophages are evidences of chronic inflammation Verruca may be distinctly papillary in character so that large excres-



FIG 3



FIG 4

FIG 3—Marked inflammatory changes with newly formed connective tissue and blood vessels  
FIG 4—Marked thickening and fibrosis of synovial surface Fibroblastic tissue in sub synovial surface  
New formed blood vessels filled with blood cells Fibroblastic proliferation of the villi

cences are joined by thin pedicles of the synovial sheath The vessel walls are increased in thickness, and their contents are full of red blood-cells and cells in a stage of degeneration Decomposed blood pigment may be found within the capillaries or in the tissue Bick<sup>32</sup> states that in a study of synovial membrane in chronic arthritis regardless of the eventual outcome of the studies in their etiology, the observed effect in the synovial tissue is within a reasonable range always the same

In this series both the hyperplastic or atrophic, and the hypertrophic or osteo-arthritis types were operated upon Changes in the synovial membrane of the two types differed slightly In the hyperplastic type there was more dense fibrous-tissue formation, with perhaps a more marked round-cell infiltration In the osteo-arthritis type there is a greater fatty and hyalin degeneration It is often difficult to judge from the pathology of the synovial membrane alone what type of arthritis one is dealing with Osteophytic deposits on the periphery of the articular cartilage may be noted in both Synovectomy in this series was performed on several cases of recurrent



hydrops of the knee-joint (acute recurrent serous synovitis) One case was of interest because it showed a recent strangulation of a villus with thrombosis of its vessels (Fig 5)

*Indications for Operation and Results*—No fast rules can be established for the performance of this operation Cases should be selected with the utmost care In general, any arthritic joint which is associated with pain, swelling, limitation to the normal range of motion, and X-ray indications of clouding and thickening of joint spaces should be subjected to the operation of synovectomy

Often the pain is general over the knee-joint, but as a rule the patient will indicate a more definite point, on the inner side of the knee below the

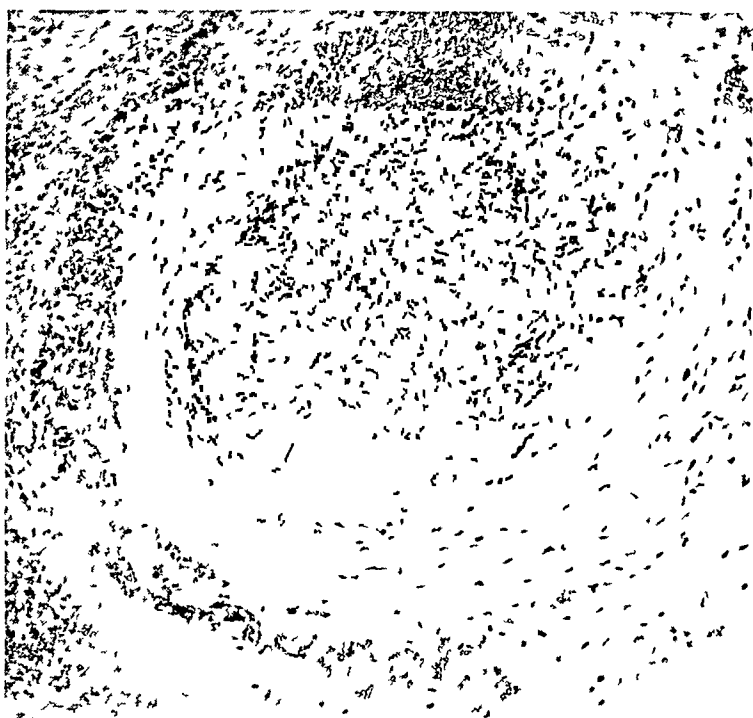


FIG 5—Organizing thrombus Note the inflammatory cells surrounding the vessel

lower border of the patella The reason for this is the greater amount of strain put upon the inner side of the knee due to weight-bearing There may also be pain in the popliteal region This is due to tension in the posterior compartment of the knee-joint as a result of accumulation of fluid and to a shortening of the ham-string muscles and to a contraction of the posterior capsule Occasional complaint is made of pain at the head of the fibula This is caused by the involvement of a branch of the peroneal nerve

Effusion in the joint is very common The swelling may be uniform, causing a prominence above the patella More often there are irregular indurated masses below the patella, and on the lateral surfaces of the joint

Limitation of motion is almost invariably present Both flexion and extension of the joint are affected, giving rise to faulty weight-bearing

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The roentgenogram shows a thickening and clouding of the spaces in the joint which are normally found clear. This obscurity is due to synovial thickening, and to the accumulation of fluid. The method employed in our earlier cases to visualize these joint spaces, was by the introduction of carbon dioxide (Fig 6). By this means the outline of the synovial membrane, its distortions and any foreign substance otherwise invisible could be easily determined.<sup>33</sup> Changes on the periphery of the articular cartilage such as



FIG 6—Lateral view of knee joint inflated with carbon dioxide gas showing enlargement of pad of fat, distension of the suprapatellar space, and bands of adhesions running through it. The posterior compartment of the knee joint is clear. This patient had a hypertrophic villus synovitis.

hypertrophic deposits are no contra-indications for operation. On the contrary, they confirm the pathological picture which may be expected in the joint. Nor is age a determinative factor in operation. The youngest patient I have operated on was twenty-five, and the oldest sixty, the average age being forty. Of twenty-five patients operated on, fifteen were men. Of these cases, twenty-two had good results, one was a poor result, one developed

an ankylosis, and one had a recurrence of pain about six months after the operation. Of the twenty-two cases, 50 per cent had completely restored function, complete loss of pain and no recurrence of swelling. Of the others, the results varied with the general physical condition of the patient, and in accordance with the other joints involved. In the cases of multiple arthritis, the other joints were distinctly benefited by the operation. It was surprising to note the increase of circulation to the extremities, and the added sense of warmth and well being. The function in the joints improved with the lapse of time, so that the oldest case, a woman sixty-five years of age, who was operated on in 1925, has a complete range of motion and freedom from pain. One must not judge the results of synovectomy the first few months after the operation. Improvement continues with the use of the knee.

Of the three bad results, one developed a secondary infection after the operation, which resulted in ankylosis. One case was a multiple hyperplastic arthritis with erosion of the articular cartilage, and resulted in a limitation of motion. The range of motion obtained after the operation was not less than the patient had before, but nevertheless it is counted as a bad result. The third patient was also a multiple hyperplastic type and had a recurrence of pain soon after the operation. It may be stated that when there is an erosion of the articular cartilage, the results are not apt to be good as to the complete return of function, but improvement of the other joints may occur. It may also be stated that the male patients without exception had excellent results, the joints returning to comparatively normal state as to pain, range of motion and weight-bearing. The pain and discomfort after synovectomy are no greater, and in my opinion are less than after the removal of a semilunar cartilage, and the time of disability is not longer. In no case was there a complication as a result of the split patellar approach to the joint.

*Prognosis*—First, there is the ever-present danger of infection. This can, however, be obviated if not completely eliminated by a careful observation of Lane technic, and the observance of asepsis to a superlative degree. It must be remembered that due to the chronic irritation in the joint, the synovial membrane has become thickened and the lymph-nodes blocked, therefore, secondary infection of the joint is not followed as frequently by systemic absorption. In normal joints infection is followed by a rapid absorption and dissemination by the unprepared lymphatics. This warding-off process Murphy<sup>32</sup> called "Cofferdamming." Although the danger of systemic infection is minimized, the effects upon the joint are nevertheless associated with danger of ankylosis.

Secondly, there is the danger of injury to structures upon which the stability of the joint depends, such as the crucial and lateral ligaments<sup>35</sup>. This may be easily avoided by finding the line of cleavage of the lining of the joint, and not penetrating too deeply into the peri-articular structures.

Thirdly, hæmorrhage may seem alarming coming from a large denuded surface with no evident vessels for hemostasis. Compression, however, con-

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trols this bleeding and the hemoarthrosis that follows need not be aspirated since it is absorbed without difficulty

*Operation*—The anæsthetic we have used on our last cases has been the intraspinal injection of spinocaine. This has proved very satisfactory, especially in those cases associated with cardiac complications

The knee-joint is prepared the night before the operation by shaving, thorough scrubbing and antisepsis. The patient is placed in a recumbent position on the operating table with the knee slightly flexed. A tourniquet is placed around the thigh. The knee is again prepared by careful antisepsis, iodized and made ready for operation

The incision is one originated by me<sup>31</sup> and is now quite generally used (Fig 7). From a point about two and one-half to three inches above the superior border of the patella in a mid-line the incision is continued downwards to the upper border of the patella, circling the outer border, to the lower mid-line, and ending at the tibial tubercle. The skin is then reflected on both sides, exposing the tendinous portion of the quadriceps extensor, and its covering over the patella. A linear incision is now made in the mid-line through its full thickness. By means of a chisel the patella is split. This leads directly into the joint. Scissors are introduced through this opening and the incision is carried upward and downward through all the structures. By this means the infrapatellar pad of fat is cut in two. As a rule a considerable quantity of fluid and blood escapes from the joint, and with it a grayish mass of mucus. This mucigenous substance is very tenacious and is often adherent to the synovial surface, especially to the suprapatellar space. This by-product is entirely wiped out by means of a sponge, leaving a dark and reddish hyperæmic and thickened synovial membrane exposed.

The knee is now flexed to its full limit. The split patella is retracted, and the dissection and extirpation of the synovial membrane are now begun. By means of scissors and tissue forceps the split pad of fat is now dissected out (Fig 8), first one side and then the other, and with it as much of the synovial membrane on the lateral joint surfaces as is possible, avoiding injury to the semilunar cartilages. Some operators advise the removal of the cartilages, notably Allison<sup>10</sup>. When there is erosion, it would seem advisable to remove them. However, I have never found occasion to do so.

The synovial membrane from the suprapatellar pouch is now dissected out, which completes the synovectomy. Before closure a search should be made for any loose tags of synovial membrane so as to leave the joint with a smooth and clean surface. All hæmorrhage is controlled by either ligation or hot packs. The closure is made by sewing the capsule from above downward by continuous interlocking stitch, down to the upper border of the patella. Interrupted sutures are then introduced through all the

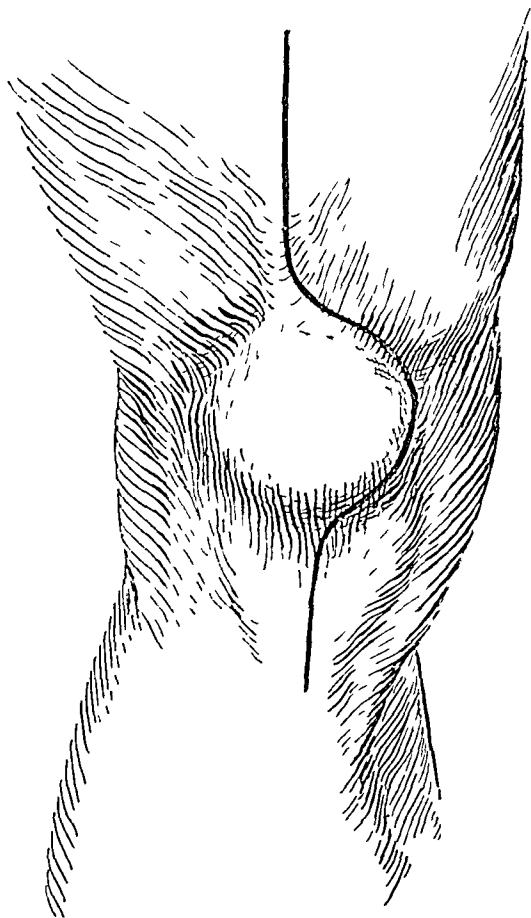


FIG 7—Incision for approach to the knee joint, first described by the author and has been used where a wide approach is desired. This incision has the advantage in avoiding a scar over the patella.

layers, covering the patella, paying special attention to coaptation of the bone edges. The lower remaining portion of the incision is then closed in the same way as is the upper. Chromic catgut is used for all deep sutures. The subcutaneous tissues are closed by a running plain catgut suture, and the skin incision is closed by means of dermal horsehair or silk.

No drain is ever used in the joints. A posterior molded plaster splint is applied. This is retained for about six days, when it is removed and passive motion executed. The patients are allowed out of bed in a wheel-chair about the tenth day, and encouraged to get around on crutches as soon as the pain subsides. Active and passive exercises are carried out by a trained physiotherapist, and weight-bearing allowed at the end of the second week.

The dressings are not disturbed for ten days, and the sutures not removed until the skin edges show signs of healing. Too early removal of the sutures often leads to a retraction of the incision, resulting in secondary infection.

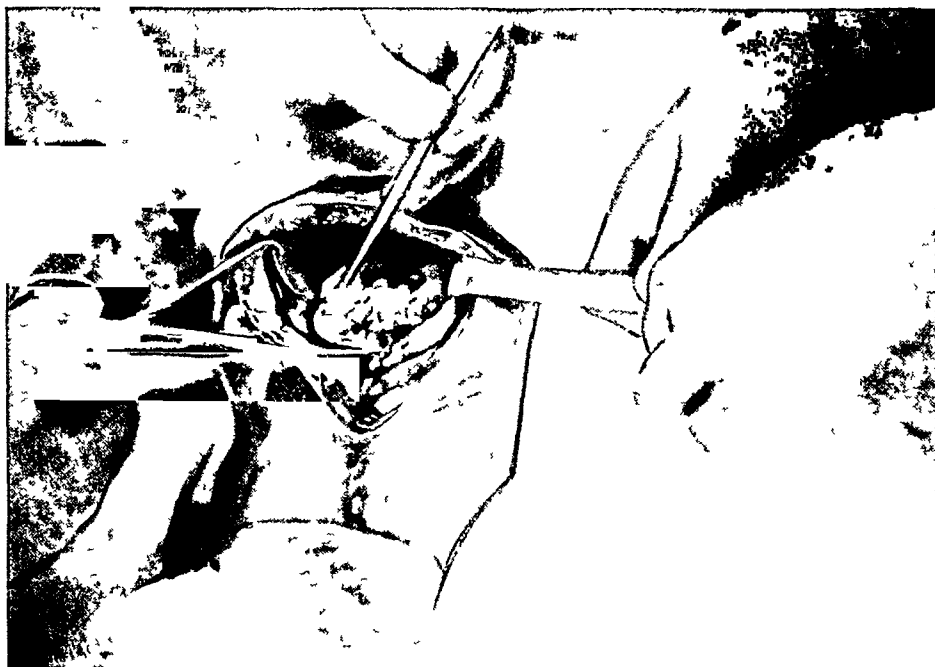


FIG. 8—Dissection of fat pad and synovial membrane

If effusion or distension of the joint occurs as a result of an oozing hæmorrhage into the joint, it is seldom advisable to aspirate, since absorption of the fluid or blood takes place within a short time after the operation. There is always a danger of secondary infection from aspiration. This results by introduction of microorganisms through the puncture, which leaves a puncture wound, allowing a constant oozing of serous and serosanguineous fluid.

The application of heat by means of infra-red lamp lessens the pain after the operation. The dressings must not be disturbed when heat is applied. A few grains of codeine help to control the pain.

Faradic current applied to the muscles of the leg and thigh helps to maintain muscle tone, and restores function more quickly. This is especially true of the quadriceps group.

The degree of pain is surprisingly little in proportion to the magnitude of the operation. Patients have commented that the pain in the joint before operation was greater than the pain from the operation. Most of the patients stated that the pain and discomfort in the other joints were definitely improved. This observation has also been made by other surgeons. Patients who were suffering with a bilateral arthritis of the

## KNEE-JOINT IN CHRONIC ARTHRITIS

knees refused operation on the second knee because the pain in the unoperated knee was mitigated as a result of the synovectomy

*Conclusions* —(1) Synovectomy in properly selected cases, and in experienced hands, gives rise to striking results

(2) The operation can be easily performed under spinal anaesthesia

(3) In most cases it lessens or removes pain, improves the range of motion in the joint, and gives rise to a warmth and sense of well-being in the extremity

(4) There is an improvement in other joints in cases of multiple arthritis

(5) The improvement of function continues long after the operation

(6) The age of the patient is no contra-indication

(7) The adhesive or the multiple proliferative types with erosion of the articular cartilage give the poorest results

(8) The monarticular osteo-arthritic, and the atrophic without erosion of the articular cartilage give the best results

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# SITUS TRANSVERSUS VISCERUM

## REPORT OF CASE WITH CHOLELITHIASIS

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THE primary interest of situs transversus, situs inversus viscerum, or transposition of the thoracic and abdominal viscera, is merely academic, as its incidence is a medical curiosity. Existence of this anomaly is entirely compatible with normal health, longevity, and reproductivity. Major interest, however, attaches to its occurrence in individuals with disease conditions requiring surgical relief.

Estimations of incidence are at variance. Upwards of 400 cases have been reported, but this by no means furnishes a true record of its incidence, undoubtedly many more cases have occurred than have been reported, because they have escaped anything more than casual notice.

It has been reported almost entirely in connection with the so-called left-sided appendicitis. But the majority of these case reports leave a great deal to be desired in the way of data sufficiently conclusive to classify the cases as bona fide transposition, failure of colon to rotate, or simple wandering appendix due to mobile cæcum, long mesentery, adhesions, *etc*.

The most recent and reliable figures I have been able to find are those quoted by Counseller, who states "In The Mayo Clinic, ten cases were observed in a registration of 347,000 patients between 1910 and 1927. It was noted once in 35,000 routine examinations in the army." The remarkable parallelism of these figures is very striking.

In the presence of true dextrocardia one is probably justified in assuming that the abdominal viscera as well are transposed, as the condition is generally complete. However, comprehensive skiagraphical examination of the gastrointestinal tract is the only scientific method of determining the question. And in the final analysis, only operative or necropsy findings are conclusive.

In the individual whose case report is abstracted below, the transposition was complete. There was dextrocardia, the larger lobe of the liver was on the left and carried with it the gall-bladder, which emptied into the duodenum to the right, the pylorus pointed to the left, the cæcum and appendix were in the left iliac fossa, and the sigmoid occupied the right iliac fossa.

CASE—A woman, aged forty years, white, entered St. Joseph's Hospital August 14, 1931, for interval cholecystectomy and appendectomy. The diagnoses on admission were (1) Cholecystitis, chronic, non-suppurative, moderately severe, with cholelithiasis, the gall-bladder skiagraph exhibiting multiple faceted calculi. (2) Situs transversus viscerum, complete. (3) Arthritis, chronic, recurring, non-suppurative, multiple, proliferative type, involving all the joints, large and small, of both extremities, and the



cervical and upper half of the dorsal spine, characterized by progressive limitation of motion and function with deformity of involved joints, most marked in wrists and smaller joints of both hands (4) Pyelitis, chronic, suppurative mild, bilateral Insofar as the transposition of viscera is concerned, the early history of the patient was of importance only secondarily, as showing the many vicissitudes of disease through which the patient had passed without the anomaly having been discovered She had experienced the usual diseases of childhood and at the age of ten years had an attack of acute rheumatic fever which involved practically all the larger joints successively However she made a good recovery without residual effects

She stated that from childhood she had always been conscious that the maximum heart impulse was on the right side, but that not till much later in life was the true significance of the anomaly discovered She had never been told of the existence of any abnormality of her viscera until her present hospitalization

At the age of twenty, while in training as a nurse, she was operated upon through the classical incision for right-sided iliac pain which was diagnosed as acute appendicitis No appendix was found and patient states that she was told that the many adhesions covering the appendix made its removal inadvisable Later, during the same illness it was found that the patient was heavily infested with malarial parasites

During the World War she entered the military service as a nurse and served in hospitals along the northern Atlantic seaboard She contracted influenza in 1918, and about one month later developed an acute arthritis which localized chiefly in the ankles, shoulders and hands She did practically no duty for four months, though apparently not ill enough to be hospitalized She was then transferred to a milder climate and was able to do duty for about only two months before she was hospitalized May, 1919, with a diagnosis of chronic fibrinous pleurisy of both bases, this condition was complicated by subacute arthritis of all joints of both extremities and both mandibles There was only slight improvement in hospital, and she was discharged from the military service three months after admission, on certificate of disability No mention was made of the situs transversus in her medical records on admission or discharge from the military service

Since 1919, the patient has never been entirely free of joint symptoms, the arthritic process has manifested itself by periods of remissions and exacerbations at varying intervals There has been a steady progression in the disability due to limitation of motion and function in the involved joints Though there does not appear to be bony ankylosis as yet, extra-articular fibrosis, contractures, and trophic changes have resulted in crippling and unsightly deformities, particularly of the hands

During the past few years the patient has been treated at intervals for cystitis and pyelitis of low grade It was during one of the cystoscopic examinations that transposition of the viscera was discovered by the urologist

The patient was operated upon under spinocain, synergized by intravenous sodium amytal the anæsthesia was ideal Aside from the difficulty of disposing the limbs of the patient on the table, because of the arthritic deformities, the operation was absurdly easy The entire anatomy of the abdomen was reversed The gall-bladder with contained stones and a fat appendix were removed through a left rectus incision

The patient made an uninterrupted recovery and left the hospital twenty-three days after operation When sufficient time has elapsed to assess the benefit derived from the removal of these possible foci, it is contemplated to attempt rehabilitation of the patient's joints by plastic surgery The possible application of sympathectomy has been considered

Explanation of the origin of this condition must be largely speculative There are certain things we know and others we may surmise (Fig 1) For instance, the anomaly is teratological without doubt, and occurs at an early stage of phylogenetic differentiation of the embryo Observation of

## SITUS TRANSVERSUS VISCERUM

this mirror transposition in duplicate monsters has led to the suggestion that the person exhibiting it is the right half of an original duplicate monster in which the left was resorbed. However, the idea is not tenable because the anomaly is rare in one-egg or identical twins, and the latter are merely a variation and the usual one, of bisomatous monsters. Moreover, there is no embryological or logical reason why the simple fact of division of the blastomere *per se* should be followed by abnormal development in a particular half, either the right or left.



FIG. 1.—At first glance one would think of kidney stones. Second thought brings doubt, chiefly because of the structure of the stones.

Embryology furnishes the most acceptable explanation in the development of the cardiovascular system from the primitive aortæ and aortic arches. The sites of the abdominal viscera are determined by the course along which their circulation evolves. In the normal schema, the arch of the aorta is formed by the fourth left aortic arch, the descending aorta by the fusion of the right with the left dorsal aorta, the fourth right arch and the right dorsal aorta disappear caudad of the third arch. If this process is reversed, the fourth right arch persists and forms the aortic arch, the heart occurs on

the dexter side, the aorta arches to the right and the descending aorta and subsequent venous system development bring about the sinister position of the abdominal viscera

Analogous confirmation of this is obtained by a study of comparative anatomy In fish, the aortic arches persist and give off branches to the gills where the blood is oxygenated, in birds the fourth right aortic arch forms the arch of the aorta, in reptiles the fourth arch on both sides persists and there is a double aortic arch



FIG 2 —Skiagraph confirms dexter position of stomach and clinches diagnosis of situs transversus. Needless to say, complete roentgenographical examination of the entire gastro intestinal tract was had

It is most remarkable that this patient, who is herself a graduate nurse, could have passed through so many medical hands without the existence of this anomaly having been definitely established, until she was forty years of age. Dextrocardia was tentatively diagnosticated in 1919, during the course of a skiagraphic examination (Fig 2) of the chest for symptoms suggestive of pleurisy. At this time complete transposition of all viscera was suspected and skiagraphic examination of the gastro-intestinal tract was requested by

the radiologist, there is no record, however, of its having been done. Neither was the patient advised of the significance of the above observation.

The physical examinations of this patient on admission and discharge from the military service do not mention any departure from the normal insofar as the heart is concerned, nor does it appear that the anomaly was enumerated as a diagnosis on her clinical records.

It is recalled that she was operated upon at twenty years of age for appendicitis, the usual right rectus incision was used and no appendix found. Obviously the underlying condition was not recognized. The right-sided pain had by the patient can be explained by splenic pain incident to a malarial infestation discovered subsequently.

The lesson to be learned from this case is *the fundamental importance of a careful physical examination of all patients*. It can be argued that transposition of viscera is an unlikely contingency that beyond a needless and fruitless operation in the case at issue, no great harm has resulted from failure to recognize the anomaly. Still, it is hardly a matter for congratulation.

# BRIEF COMMUNICATION

## MORTALITY FOLLOWING GALL-BLADDER SURGERY

AMONG the many excellent articles on biliary surgery in the September, 1933, number of *ANNALS OF SURGERY* is one by Eiss, entitled "Conservation of Hepatic Function in Gall-bladder Operations." This article again draws our attention to a very important point, namely—the occasional sudden and unexplained death following operation on the biliary tract, which, for want of a better name, is called "liver death."

Eiss, in his communication, discusses the various tests of liver function that we now have at our command, mentioning in particular the dye-retention test as described by Graham, and shows that in the Barnes Hospital where this test is used routinely in all patients upon whom any type of biliary surgery is contemplated, the mortality of cholecystectomy has been reduced from 6 per cent to 4 per cent. This reduction has been brought about by treating pre-operatively with glucose and calcium the patient with excessive dye retention.

We know that the liver has a multiplicity of functions and at the present time we have no definite test that will give us a true index of the amount of liver function present in the presence of biliary disease, although perhaps the dye-retention test is our best test. We do know that the metabolism of glucose is an important function of the liver and apparently the function most disturbed by infection in the liver and biliary tracts.

Until we have some fairly exact liver-function test available to surgeons who are compelled to operate upon patients with gall-bladder disease, comparable to the kidney-function test, it would seem that every patient before undergoing an operation on the gall-bladder or biliary passages should be looked upon as a bad risk and treated as such in more or less of a routine manner as described below.

The purpose of this communication is to point out that the mortality in gall-bladder surgery which is high can be reduced by looking upon every patient with disease of the biliary tract, whether jaundiced or not, as a bad risk and by giving adequate pre-operative treatment with glucose to every patient. If one is working in a clinic or has at his command the facilities to carry out the dye-retention test, perhaps it is safe to treat pre-operatively only the bad-risk case, but the bulk of gall-bladder surgery throughout the country is done by men who do not have facilities for carrying out this test. By regarding every patient as a bad-risk patient, the mortality certainly can be reduced.

Practically it is quite simple, both for the patient and the surgeon, to build up the glucose reserve before operation. In this day of economic stress where pre-operative hospitalization is a financial hardship in many instances, the

patient can be instructed to take sugar in large amounts for several days before going to the hospital. In the acute case which requires immediate hospitalization, the glucose can be given by mouth if well tolerated, and if not it can be given intravenously. By this simple procedure the so-called "liver death" can be reduced to a minimum.

In addition to increasing the glucose reserve of the patient, several other points are important and quite essential, and these are as follows:

(1) A carefully executed operation, paying due respect to the anatomy of the bile passages, *etc*

(2) A carefully selected anæsthetic. In my own experience, spinal anæsthesia is the anæsthetic of choice in the patient who is potentially a bad risk. Avertin supplemented with ethylene is second choice and ether is the last to be chosen and is seldom used in my own practice.

(3) Continuous gastric lavage by means of an indwelling nasal catheter if there is any tendency to regurgitation and dilatation of the stomach. Of course the fluid balance during the first few days must be maintained, and in case of vomiting this is done by giving glucose solution intravenously and subcutaneously.

By this simple and more or less empirical procedure of building up the glucose reserve in all patients about to undergo biliary surgery, a great many lives can be saved and the number of so-called "liver deaths" kept to a minimum.

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# MEMOIRS

WILLIAM McDOWELL MASTIN

1853-1933

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DR WILLIAM McDOWELL MASTIN was born in Mobile, Alabama, July 3, 1853. He was descended from a long line of ancestors, originally of English stock, who in the territorial days of Alabama had settled and prospered in



WILLIAM McDOWELL MASTIN, M D

Huntsville. A typical Southern gentleman by character and birth, Doctor Mastin inherited a pride in his medical lineage which was historical on both sides of his family tree. His father, Dr. Claudius Henry Mastin, was recog-

nized by the profession as the "Nestor of Surgery" in the South. He, in turn, had been influenced in his choice of a medical career by the example of his grand-uncle, Dr Claudius Henry Levert, a celebrity in the early history of the state. Again, Doctor Claudius, the father, had married Miss Eliza McDowell, a lineal descendant of Ephraim McDowell, of Dansville, Kentucky—the "Father of Ovariectomy"—for whom young William was named. From this union four children were born, two sons and two daughters. The sons, following the example of the father who had graduated M D in the University of Pennsylvania in 1849, took to Medicine and were likewise graduated M D s in the same university, the older, William McD, in 1874, and Claudius Henry Jr, in 1884. The loyal attachment of the Mastins for the University of Pennsylvania was a marked characteristic of the family.

One cannot refer to Dr William McD Mastin's family antecedents without recalling the important rôle played by his distinguished father in the early history of the foundation and organization of the American Surgical Association. In fact, Dr Claudius Mastin, a personal friend and devoted admirer of Dr Samuel D Gross, the illustrious founder, became from the foundation in 1880 one of Doctor Gross' most active lieutenants in the organization. Though an ardent Confederate and surgeon of high rank in the Southern army, Doctor Mastin was one of the first after the war to disregard all sectional prejudices and party feeling in uniting the medical profession of the North and South and in restoring the national spirit in medical and scientific associations of the country. That his services were duly appreciated is shown by his successive election to the second vice-presidency in 1883–1884, the first vice-presidency in 1889–1890 and to the presidency in 1890–1891. Furthermore, he was one of the most influential members of the Council from 1891–1896.

It was through the untiring efforts of Dr Claudius Mastin, with the cooperation of the Fellows of this association and the Alumni of Jefferson Medical College of Philadelphia, that the Samuel D Gross monument in Washington was erected. He wrote the dedication on the monument and his address at the unveiling is a beautiful tribute to the illustrious founder and a model of chaste and eloquent speech.

Not content with his work in the American Surgical Association, Doctor Claudius founded and organized the Triennial Congress of American Physicians and Surgeons. He also shared in the founding of the American Association of Genito-Urinary Surgeons in 1886 (President in 1895–1896) and was one of the organizers and trustees of the First Pan-American Medical Congress in 1891.

These and other numerous activities in national and regional organizations are mentioned not only to recall Dr Claudius Mastin's invaluable services to this (American Surgical) Association, but because of the influence that his commanding position exercised upon the character and future career of his oldest son William who also became a Fellow of the Association in 1887.



William McDowell Mastin was graduated as a Doctor of Medicine at the medical school of the University of Pennsylvania in 1874, just as his father had been twenty-five years before him. He supplemented his medical course by an internship of a year in the University Hospital and another in the Wills Ophthalmic Hospital of Philadelphia. Then followed a tour devoted to the medical clinics of London and Paris. He returned to Mobile in 1877, where he settled permanently to practice medicine in association with his father. In 1898 Dr. Claudius H. Mastin passed away and his son, William then forty-seven years of age, not only had succeeded him in his large practice but had become the leading surgeon in Mobile and was nationally recognized as one of the ablest and most scholarly surgeons of the South.

The years 1879-1913, that is, from his twenty-fifth to his fiftieth years, mark the period of Dr. William Mastin's greatest surgical and literary activity.

His earliest papers on "Ametropia in Its Relations to the Inflammatory Lesions of the Eye and Lids" (1879) and on the "Initial Lesion of Syphilis on the Palpebral Conjunctiva" (1880), show the influence of his early ophthalmic training.

Among his more massive and monographic papers are the following: A collective study on "Tracheotomy for Croup in the United States: an Analysis of 863 Operations" (Gaillard's Med Jour, vol. XLV, 35 pp., N. Y., 1880), "Venous Blood Tumors of the Cranium, Connected with the Sinuses of the Dura Mater" (ANNALS OF SURGERY, 40 pp., 1885, enlarged in Jour. Am. Med. Assn., 93 pp., September, 1886), chapters on "Abdominal Section," Buck's Reference Handbook, "Ulcer and Ulceration," in Bryant and Buck's American Surgery, vol. III, 1907, "Recurrence at a Late Period after Operation for Cancer of the Breast," based on personal observations (ANNALS OF SURGERY, vol. XLVIII, 1908), "Resume of the Surgical Treatment of Ano-rectal Imperforation in the New-born, with Report of Personal Cases" (Surg., Gynec., and Obst., vol. VII, 1906).

What may be regarded as his magnum opus and literary monument is his "History of Filaria Sanguinis Hominis, Its Discovery in the United States," based upon his personal studies of the parasite as he had identified in Mobile in a case of chylocele of the Tunica Vaginalis Testis, (ANNALS OF SURGERY, vol. VIII, pp. 321-362, 1888) with a bibliography of 126 titles.

How highly he was esteemed by his colleagues in the South is shown by his unanimous election to Fellowship in the Southern Surgical Association in 1890, without the formality of an application—an unprecedented and unique compliment in that organization.

During the most active years of his career he was chief of the surgical staff of the Providence Infirmary and of the City Hospital of Mobile. It was by his operations in these hospitals and especially in the Providence Infirmary that his widespread reputation as an exceptionally skillful and conscientious surgeon was established.

At the age of seventy-five years he virtually retired, though still advising some of his old clients and faithful friends. In the meantime, his sight had been impaired and this added further to his seclusion by depriving him of the pleasures of his library, which had always been one of the greatest enjoyments of his studious and intellectual life. Finally and just as he was

## MEMOIRS

stepping on the threshold of his eightieth year, the end came in an attack of bronchopneumonia which peacefully and painlessly ushered him into the eternal slumber, February 3, 1933

In November, 1882, Doctor Mastin married Miss Margaret L. Crawford, of Mobile, who survives him. Three children were born from this union: Margaret McD. and Claudius Henry, who died at an early age from diphtheria contracted before the days of antitoxin, and a daughter, Miss Zemula Crawford Mastin, now residing in Mobile, who lived to be, with her mother, the greatest comfort of his life.

RUDOLPH MATAS

## WALTER ELLIS SISTRUNK

1880-1933

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THE death of Walter Ellis Sistrunk is a loss to American surgery, to the American Surgical Association and to the community in which he carried on his work. His surgical career was outstanding because of a well-endowed mind, a thorough fundamental training, a long apprenticeship, an originality



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WALTER ELLIS SISTRUNK, M D

of thought, tireless industry, and love of his work. Those who were closely associated with him in the early days predicted the high place he had attained in the surgical profession, and his death will be mourned not only by surgeons of this country but also by foreign surgeons who have on many occasions

paid tribute to the contributions through which he made conspicuous advances in many surgical fields

Doctor Sistrunk was born in Tallahassee, Alabama, in 1880. He received the degree of Ph G. in 1900, from the Alabama Polytechnic Institute, and of M D from Tulane University in 1906. He was interne in the Charity Hospital, New Orleans, from 1904 to 1906, was assistant house surgeon in the New Orleans Sanitarium from 1907 to 1909, and practiced at New Orleans from 1906 to 1909 and at Lake Charles, Louisiana, from 1909 to 1910. In 1911, he went to The Mayo Clinic as assistant in pathology and was appointed first assistant in surgery in 1912, assistant surgeon in 1914, and attending surgeon and head of a section in the division of surgery in 1915. From 1918 to 1929 he was associate professor of surgery, The Mayo Foundation, Graduate School, University of Minnesota.

During this period he displayed an intense interest in all surgical problems but particularly he had a large part in a study of the diseases of the thyroid gland, the breast and the colon and the development of surgical treatment of these diseases. The operation which he proposed for the cure of thyroglossal duct cyst revolutionized the surgical treatment of this condition. He was one of the early advocates in this country of the Kondoleon operation for elephantiasis. His surgical experience was enormous, and the thoroughness with which he assembled the results of this experience and the clarity with which he presented it gave to his publications both the weight of authority and unusually instructive qualities. For twenty years, moreover, parasitologists and internists have acknowledged a debt to him for pointing out that amoebiasis is widespread in this country.

The accidental and tragic death of Doctor Sistrunk's son, David, and his love for his homeland in the South led him to sever his connections with the clinic in 1929. He associated himself with one of his former assistants, Dr G. D. Mahon, in Dallas, Texas, and here he continued to practice his profession until his death three years later. Those of us who knew him best will remember him for his kindness, for his devotion to the highest surgical ideals and practice, for his enthusiasm, for his ingenuity and for his loyalty to his colleagues. These qualities, the devotion of his pupils, and the permanency of his scientific contributions will perpetuate the name and accomplishments of Walter Sistrunk.

DONALD C. BALFOUR

## THE JUBILEE YEAR OF THE ANNALS OF SURGERY

WITH the issue for January, 1934, the ANNALS OF SURGERY will enter upon its fiftieth year of publication as a "Monthly Review of Surgical Science and Practice"

It will still bear upon its title page as its Editor, the same name which its first number bore, Dr Lewis Stephen Pilcher, who will continue to actively determine its contents. Its publishers, The J B Lippincott Company, have made it in the past a model of typography, a proper setting for its important work. They pledge for the future to lessen no whit its high standard.

The first monthly periodical to be published in the English language devoted exclusively to Surgery, it was the outcome and the representative of the new Surgery that sprang from the union of Anesthesia with Pathology, attended by Antisepsis. During all the years since it has exhibited in a high degree the spirit of the best Surgical effort. It enters upon its fiftieth year with enthusiastic plans for the continued realization of that spirit and a full appreciation of and deep gratitude for the approval which it has received from the surgeons of the World, and with ambitions to make its future excel its past.

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